

STED JOURNAL

Journal of Social and Technological Development



IZDAVAČ: UNIVERZITET PIM - BANJA LUKA
PUBLISHER: UNIVERSITY PIM – BANJA LUKA

Banja Luka, November 2025.

STED JOURNAL

Journal of Social and Technological Development - Časopis o društvenom i tehnološkom razvoju

Izdavač - Publisher

UNIVERZITET PIM, Banja Luka – UNIVERSITY PIM, Banja Luka

Za izdavača – For Publisher

Dr Dejan Kojić, vanredni profesor – Direktor

Dr Dejan Kojić, Associated Professor – General Manager

Glavni i odgovorni urednik – Editor in Chief

Dr Dejan Kojić, vanredni profesor

Dr Dejan Kojić. Associated Professor

Međunarodni uređivački odbor – Internacional Editorial board

Dr **Jelena Pavličević**, University of Novi Sad, Faculty of Technology, Novi Sad, **Serbia**;

Dr **Milena Marinović-Cincović**, University of Belgrade, The Vinča Institute of Nuclear Sciences, Belgrade, **Serbia**;

Dr **Darina Duplakova**, Technical University of Kosice, Faculty of Manufacturing Technologies with a seat in Presov, Institute of Advanced Technologies, Presov, **Slovakia**;

Dr **Nikša Grgurević**, Faculty of Management, Herceg Novi, **Montenegro**;

Dr **Julya A. Zeunkova**, Medical Institute Peoples, Friendship University of Russia, **Russia**;

Dr **Benea Marius Calin**, Politehnica University Timisoara, Faculty of Engineering Hunedoara, **Romania**;

Dr **Ayse Zehra Aroguz**, Istanbul University-Cerrahpasa, Engineering Faculty, Istanbul, **Turkey**;

Dr **Isaac Lera**, University of the Balearic Islands, Dept. of Mathematics and Computer Science, **Spain**;

Dr **Hafiz Imtiaz Ahmad**, associate professor, Faculty of Business, Higher Colleges of Technology, Ali Alin, Abu Dhabi, **UAE**;

Dr **Yajnaya Dutta Nayak**, Assistant Professor, P.G. Dept. of Commerce, Khallikote Auto. College, Berhampur, Odisha, **India**;

Dr **Milena Špírková**, Institute of Macromolecular Chemistry, Prague, **Czech Republic**;

Dr **Tibor Gonda**, Faculty of Business and Economics of the University of Pécs, **Hungary**;

Dr **Yaroslav Kusyi**, National University “Lviv Polytechnic”, **Ukraine**;

Dr **Boris Dorbić**, scientific-expert association “FUTURA”, Šibenik, **Croatia**;

Dr **Milan Vraneš**, University of Novi Sad, Faculty of Sciences, Novi Sad, **Serbia**;

Dr **Nenad Janković**, University of Kragujevac, Institute for Informational Technologies, Kragujevac, **Serbia**;

Dr **Bojana Ikonić**, University of Novi Sad, Faculty of Technology, Novi Sad, **Serbia**;

Dr **Mirjana Jovičić**, University of Novi Sad, Faculty of Technology, Novi Sad, **Serbia**;

Dr **Oskar Bera**, University of Novi Sad, Faculty of Technology, Novi Sad, **Serbia**;

Dr **Nevena Vukić**, University of Kragujevac, Faculty of Technical Sciences in Čačak, **Serbia**;

Dr **Marija Blagojević**, University of Kragujevac, Faculty of Technical Sciences in Čačak, **Serbia**;

Dr **Nada Damljanović**, University of Kragujevac, Faculty of Technical Sciences in Čačak, **Serbia**;

Dr **Tamara Erceg**, University of Novi Sad, Faculty of Technology, Novi Sad, **Serbia**;

Dr **Veselin Drašković**, University of Montenegro, Maritime Faculty Kotor, **Montenegro**;

Dr **Ljiljana Tanasić**, Higher agricultural school of vocational studies in Šabac, **Serbia**;

Dr **Nataša Lukić**, University of Novi Sad, Faculty of Technology, Novi Sad, **Serbia**;

Dr **Enes Sukić**, Faculty of Information technology and engineering – FITI, Belgrade, **Serbia**.

Uređivački odbor iz BiH – Editorial Board from Bosnia and Herzegovina

Dr **Mladen Ivić**, University PIM, Faculty of Economics, Banja Luka;
Dr **Ilija Džombić**, University PIM, Banja Luka;
Dr **Marijana Žiravac Mladenović**, University PIM, Faculty of Economics, Banja Luka;
Dr **Nikola Vojvodić**, University PIM, Faculty of Economics, Banja Luka;
Dr **Željko Grubljević**, Health Insurance Fond of Republic of Srpska, Prijedor;
Dr **Božana Odžaković**, University of Banja Luka, Faculty of Technology, Banja Luka;
Dr **Branko Latinović**, University Apeiron Banja Luka;
Dr **Saša Salapura**, University PiM, Faculty of Computer sciences, Banja Luka;
Dr **Predrag Raosavljević**, The Institution of Human Rights Ombudsman of Bosna and Herzegovina, Banja Luka;
Dr **Vladan Mičić**, University of East Sarajevo, Faculty of Technology, Zvornik;
Dr **Ljubica Janjetović**, University PIM, Technical Faculty, Banja Luka;
Dr **Danijela Jakanović**, University PIM, Faculty of Philosophy, Banja Luka;
Dr **Darjana Sredić**, University PIM, Faculty of Philosophy, Banja Luka;
Dr **Veljko Vuković**, University PIM, Technical Faculty, Banja Luka.

Lektor - Copy editor

Bojan Milićević

Lektor za engleski jezik - Copy editor for English

Snježana Jež

Tehnička priprema – Technical prepress

Dr Ljubica Janjetović, Assistant Professor

Adresa redakcije - Address of Editorial Office

Univerzitet PIM, Despota Stefana Lazarevića bb, 78000 Banja Luka
Phone/Fax: +387 (0)51 378 300; e-mail: editorial@stedjournal.com;

Štamparija - Printed by

Markos design and print studio Banja Luka
Tiraž: 100 primjeraka

Radovi su dostupni u vidu punog teksta na: <https://stedjournal.com/>
The Full papers are available on: <https://stedjournal.com/>

This is an open access journal which means that all content is freely available. Users are allowed to read, download, copy, distribute, print, search, or link to the full texts of the articles in this journal without asking prior permission from the publisher or the author.

DOAJ DIRECTORY OF
OPEN ACCESS
JOURNALS



Copyright license: All articles are licensed via Creative Commons CC BY-NC-ND 4.0

UVODNA RIJEČ UREDNIKA

Poštovane kolege autori, uvaženi čitaoci,

Pred vama je druga sveska časopisa STED Journal u 2025. godini koja obuhvata 8 radova. Svi objavljeni radovi su dobili pozitivnu ocjenu od strane najmanje dva nezavisna recenzenta. Recenzije su anonimne, odnosno, recenzentima se ne otkriva identitet autora i autorima se ne otkriva identitet recenzenata. Recenzenti su preporučili i razvrstavanje članaka u naučne, odnosno stručne radove. Recenzenti su svoju saglasnost za objavu rada utemeljili na ocjeni originalnosti rada, njegove aktuelnosti, ocjene primijenjene metodologije i korišćene literature.

Svakom radu je od strane Narodne i univerzitetske biblioteke Republike Srpske dodijeljen COBISS i UDK. Svaki rad ima dodijeljen DOI broj. Časopis ima analitički obrađene članke koji se objavljuju u tekućoj nacionalnoj bibliografiji i uvršten je u centralni elektronski katalog. Svi članovi uredništva imaju naučna ili nastavna zvanja iz užih naučnih oblasti koje pokriva časopis. Časopis je uvršten u ERIH+, DOAJ, CEEOL, GOOGLE SCHOLAR i OPAC citatne baze podataka.

Na zadnjim stranama časopisa je i bibliografija radova objavljenih u prvoj svesci za 2025. godinu.

Zahvaljujemo recenzentima radova koji su svojom profesionalnošću i kritičkim pristupom u velikoj mjeri doprinijeli kvalitetu objavljenih radova.

S poštovanjem,

Dr Dejan Kojić, vanredni profesor
Glavni i odgovorni urednik

EDITORS' INTRODUCTION

Dear fellow authors, distinguished readers,

In the front of you is the second issue of the scientific journal of social and technological development - STED Journal in 2025, published by the University of Business Engineering and Management. The second issue in 2025 includes 8 papers. Published papers have got a positive evaluation by at least two independent reviewers. Reviews are anonymous and reviewers do not know the authors identity. Reviewers have also suggested the sorting of papers into scientific and expert categories. Reviewers have given their consent for publishing of paper based on their assessment of originality, novelty, used methodology and literature of paper.

Each paper has been assigned COBISS and UDC number by the National and University Library of the Republic of Srpska. Each paper is assigned a DOI number. The journal has its analytically revised articles which are published in the current national bibliography, and it is included in the central electronic catalogue. All members of the editorial board have scientific or educational titles from the narrow scientific fields covered by the journal. The journal is included in the ERIH+, DOAJ, CEEOL, GOOGLE SCHOLAR and OPAC citation databases.

On the last pages of the journal, there is also the bibliography of papers published in the first issue in 2025.

We thank the reviewers of papers whose professionalism and critical approach have greatly contributed to the quality of published papers.

With best wishes,

Dr Dejan Kojić, docent
Editor-in-Chief

SADRŽAJ – TABLE OF CONTENTS

POSTIGNUĆA UČENIKA IZ BROJEVNIH IZRAZA SA VIŠE OPERACIJA STUDENT ACHIEVEMENT IN NUMERICAL EXPRESSIONS WITH MULTIPLE OPERATIONS Sladana Lolić	1
EFFECT OF SELECTED PLANT SPECIES ON THE ANTIOXIDANT AND ANTIMICROBIAL PROPERTIES OF JANJ CHEESE Danica Savanović, Ana Velemir, Aleksandar Savić, Ljiljana Topalić Trivunović, Jovo Savanović, Vesna Muždeka	8
IMPACT OF FLAXSEED CAKE HYDROLYSIS ON ANTIOXIDANT CAPACITY Tanja Krunić	20
ANTIOXIDANT AND ANTIMICROBIAL POTENTIAL OF BLACKTHORN AND RED CHERRY EXTRACTS IN NATURAL SAUSAGE CASINGS Ana Velemir, Snježana Mandić, Aleksandar Savić, Ljiljana Topalić-Trivunović, Danica Savanović	28
THE IMPACT OF ECONOMIC AND EDUCATIONAL STATUS ON ORGANIC FOOD PURCHASING: A FOCUS ON ONLINE CONSUMERS Jovana Galić	42
KOVAČEVIĆ PRED EVROPSKIM SUDOM ZA LJUDSKA PRAVA: PROCESNA FARSA I SUMNJIV PRESEDAN U ANTIDISKRIMINACIONOJ PRAKSI KOVAČEVIĆ BEFORE THE EUROPEAN COURT OF HUMAN RIGHTS: A PROCEDURAL FARCE AND A DUBIOUS PRECEDENT IN DISCRIMINATION JURISPRUDENCE Živorad Rašević, Sandra Pajić Šavija	50
THE EUROPEAN UNION GROWTH PLAN FOR THE WESTERN BALKANS AS A FORM OF FASTER INTEGRATION INTO THE EU SINGLE MARKET Manja Đurić Džakić	66
NEGATIVAN UTICAJ CHATGPT-A NA OBRAZOVANJE NEGATIVE IMPACT OF CHAT-GPT ON EDUCATION Vesna Simikić, Veljko Aleksić	74
GUIDELINES FOR WRITING SCIENTIFIC PAPER FOR STED JOURNAL PUBLICATION TEMPLATE	83 84
BIBLIOGRAFIJA – STED JOURNAL 7(1), maj 2025 BIBLIOGRAPHY – STED JOURNAL 7(1), May 2025	88

POSTIGNUĆA UČENIKA IZ BROJEVNIH IZRAZA SA VIŠE OPERACIJA

Sladana Lolić

Univerzitet u Banjoj Luci, Filozofski fakultet, Bulevar vojvode Petra Bojovića 1A, 78 000 Banja Luka, Bosna i Hercegovina, lolics537@gmail.com

ORIGINALAN NAUČNI RAD

ISSN 2637-2150

e-ISSN 2637-2614

DOI 10.63395/STEDJournal0702079L1

UDC 159.954/.956-057.874:37.081.315.7

COBISS.RS-ID 143555585

Received: 08 July 2025.

Revised: 18 July 2025.

Accepted: 21 July 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Autor za korespondenciju:

Sladana Lolić, Univerzitet u Banjoj Luci, Filozofski fakultet, Bulevar vojvode Petra Bojovića 1A, 78 000 Banja Luka, Bosna i Hercegovina, lolics537@gmail.com



Copyright © 2025 Sladana Lolić; published by UNIVERSITY PIM. This work licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.

Citation: Lolić, S. (2025). Postignuća učenika iz brojevnih izraza sa više operacija. *STED Journal*, 7(2), 1-7.

<https://doi.org/10.63395/STEDJournal0702079L1>

APSTRAKT

Učenje je vrijednost za svakog učenika, za svaku školu, za roditelje, nastavnike i za društvo u cjelini. Brojna istraživanja pokazuju da se vaspitno-obrazovni efekti mogu ostvariti i u tradicionalnoj (frontalnoj) nastavi, ali rezultati eksperimentalnih istraživanja u većini slučajeva pokazuju da se pod uticajem inovacija i savremenih strategija, metoda i postupaka lakše ostvaruju vaspitno-obrazovna postignuća koja se kompleksno mogu posmatrati u kontekstu ishoda (rezultata)

istraživanja koji se odnose i na vaspitanje i na obrazovanje. Primjena novih pristupa u učenju dovodi do razvijanja stvaralačkog, kreativnog mišljenja učenika, nastavni proces postaje kreativniji. Cilj ovog rada je utvrditi nivo postignuća učenika rješavajući matematičke zadatke iz brojevnih izraza primjenom zadataka po nivoima složenosti, problemsko rješavanje zadataka i tradicionalni način rješavanja zadataka.

Ključne riječi: tradicionalno učenje, učenje primjenom zadataka po nivoima složenosti, problemsko poučavanje.

Ako dijete ne može učiti na način na koji mi podučavamo, možda bismo trebali podučavati na način na koji ono uči.

Ignacio (Nacho) Estrada

UVOD

Početna nastava matematike mora biti kvalitetna, zanimljiva, dinamična, raznolika i stalno intelektualno podsticajna za učenike. Tradicionalni načini učenja i poučavanja sadržaja početne nastave matematike primjenom različitih metoda, oblika, problemskih, logičkih zadataka različitih nivoa složenosti, kritičkog mišljenja i promišljanja je buđenje i podsticanje učenika da kritički rješavaju problemske situacije, stalno zaključuju, povezuju nastavne sadržaje i na taj način njeguju kritički osvrt, umjesto preopterećivanja i pamćenja učenika velikim brojem činjenica i zadataka. U XXI vijeku stvaralaštvo učenika je jedna od najvažnijih karakteristika uspješnih učenika. Stvaralaštvo svoje korijene ima u latinskim terminima u značenju stvoriti nešto novo, kreirati nešto novo, odnosno prvenstveno se odnosi na sposobnost stvaranja i predstavlja karakteristike koje treba da posjeduju pojedinci kako bi kreirali novi misaoni ili materijalni proizvod. Kreativna sticanja znanja, razvoj stvaralaštva, kreativnog

kritičkog, logičkog mišljenja u početnoj nastavi matematike učenici postižu rješavajući zadatke različitih nivoa složenosti, rješavanjem problemskih situacija i problemskih zadataka. Rješavanje zadataka iz brojevnih izraza sa više operacija na tradicionalni način, ali i primjenom ovih oblika učenja i poučavanja u početnoj nastavi matematike učenike podstičemo na stvaralaštvo.

TRADICIONALNO UČENJE U POČETNOJ NASTAVI MATEMATIKE

Pasivno učenje karakteriše tradicionalnu nastavu. Učenici pasivno slušaju, prepisuju ono što učitelj zada, odgovaraju na postavljena pitanja i dobijaju gotove informacije od učitelja. Aktivnosti učenika u tradicionalnom učenju su slušanje i gledanje. Nastava nije prilagođena prema potrebama i individualnim sposobnostima učenika. U tradicionalnoj nastavi glavnu ulogu ima učitelj. Prednost tradicionalnog načina učenja, poučavanja i rada je disciplina u razredu. Učitelj ima potpunu kontrolu u razredu.

S obzirom na to da je učitelj glavni, pretpostavka je da će učenici shvatiti gradivo početne nastave matematike. Nedostatak tradicionalnog učenja i poučavanja sadržaja početne nastave matematike je što učenici ne sarađuju sa ostalim učenicima, smanjena je mogućnost izražavanja naučenog gradiva, a samim tim učeniku postaje dosadno.

Tradicionalno učenje koje uključuje „prenošenje znanja, koje je često odvojeno od učeničkog iskustva i konkretnih životnih uvjeta“ [1, str. 4], [2], kao najstariji oblik obrazovanja i danas je prisutan u školama. Tradicionalan način rada je ekonomičan i dopušta komunikaciju sa svim učenicima u razredu i samim tim omogućuje učitelju kontrolu nad svim učenicima u razredu.

U tradicionalnoj nastavi zastupljen je samostalan rad učenika, odnosno način rada je prilagođen prosječnom učeniku. Kritičko mišljenje i promišljanje, rješavanje problemskih zadataka i situacija i samostalno istraživanje učenika ne dolazi do izražaja, odnosno spriječen je njihov razvoj, napredak i učenje. Sticanje znanja u što većim količinama je glavni cilj tradicionalnog učenja i poučavanja.

UČENJE POČETNE NASTAVE MATEMATIKE PRIMJENOM ZADATAKA PO NIVOIMA SLOŽENOSTI

Djeca u školu dolaze sa određenim iskustvima, znanjima koja su različita od učenika do učenika. Postoje razlike u kvalitetu i u kvantitetu znanja i predznanja učenika. S obzirom na to da postoje razlike u znanjima i predznanjima učenika, zadatak učitelja je da pronade te razlike i shodno njima primjenjuje individualizaciju nastavnog rada. Ispitivanjem predznanja učenika, učitelj dobija predstavu o njihovim individualnim razlikama. Te razlike se produbljuju ili smanjuju u toku nastavnog rada. Nastavnik u planiranju i realizaciji nastavnog procesa u početnoj nastavi matematike treba da polazi od tih razlika. Individualizovana nastava može se primjenjivati u realizaciji svih nastavnih predmeta, a naročito u početnoj nastavi matematike. Problemsko učenje i problemsko rješavanje zadataka primjenom zadataka po nivoima složenosti i angažovanjem učenika shodno njihovim znanjima i predznanjima postiže se maksimalan efekat u nastavi, jer je svaki učenik maksimalno angažovan shodno svojim mogućnostima.

Individualizacija i diferencijacija nastave trebalo bi da zadovolje individualne razlike svakog učenika. Primjena takvog nastavnog rada u početnoj nastavi matematike je složenije i napornije, ali su rezultati bolji jer učenika posmatramo s obzirom na njegove psihofizičke sposobnosti, zanimanje za određeno područje, tempo rada, radno iskustvo, osobine ličnosti, mogućnost usvajanja znanja, način reagovanja i slično.

Kao kriterijum podjele nastavnih zadataka uzima se karakter intelektualne aktivnosti učenika koji može izazvati određeni zadatak, što generalno zavisi od sadržaja na kome se zadaci mogu primijeniti, ali i od nivoa predznanja učenika koji je potreban da bi se dodijeljeni zadatak riješio [2, str. 86], [4]. Ovakvim vidom poučavanja i učenja početne nastave matematike nastavnik se stalno teorijski i praktično priprema, jer shodno individualnim, mentalnim sposobnostima svojih učenika, treba da utvrdi kakve su razlike među njima u sposobnostima i znanjima i na osnovu toga osmišljava zadatke

po nivoima složenosti, diferencirane zadatke, programirane materijale.

Kada je u pitanju proces kreiranja zadataka na tri nivoa složenosti, Zihlerl [5] smatra da se izrada ovih zadataka mora bazirati na normalnoj distribuciji sposobnosti kao i drugim individualnim potrebama učenika u odjeljenju u kome je 25% natprosječnih, 25% ispodprosječnih i oko 50% onih učenika koji postižu prosječne rezultate. Primjenom zadataka po nivoima složenosti u početnoj nastavi matematike, učenici mogu da koriste vještine kritičkog mišljenja. Kritičko razmišljanje može poboljšati mogućnosti kreativnog rješavanja problema ohrabrujući učenike da traže nove strategije pri rješavanju matematičkih zadataka. Istraživanja su pokazala da primjena zadataka po nivou složenosti najviše doprinosi postizanju rezultata kod učenika koji manje uče i prosječnih učenika. Rješavajući zadatke po nivoima složenosti učenici su više motivisani, više se razvijaju njihove sposobnosti jer se ne zadržavaju na istom nivou.

PROBLEMSKO POUČAVANJE U POČETNOJ NASTAVI MATEMATIKE

Rimski i antički teoretičari su zagovarali problemsko poučavanje. Kvintilijan, kao rimski učitelj, ističe da je u nastavi glavni cilj da učeniku jednog dana ne bude potreban učitelj. On se zalagao za samoobrazovanje, saradnju učenika i učitelja. Glavna misao je bila da „učenicima treba dati nekoliko kratkih uputa, po kojima će prema svojim sposobnostima, bez tuđe pomoći, moći dalje raditi“ [6, str. 172]. Pojavljuju se i zahtjevi za njihovim uvođenjem u škole. Razvojem prirodnih nauka dolazi i do novih zahtjeva za promjenu nastavnih metoda i primjenu istih u početnoj nastavi matematike. Problemsko poučavanje i pretpostavke problemskog poučavanja nalazimo kod francuskog kritičara, filozofa moralizma, proznog pisca i pedagoga Montenja (od 1533. do 1592). Montenj smatra da učenike treba staviti u situaciju posmatranja, uspoređivanja, razlikovanja i razmišljanja o stvarima. Učitelj mu mora pomoći pronalaziti i otkrivati nove spoznaje. Postavlja pitanje: „Čemu znanje bez razboritosti? A poznata je uzrečica „znati napamet ne znači znati“ [6, str. 440].

Početak XX vijeka obilježen je reformskom pedagogijom. Javlja se pokret mladih i narodnih škola, pokret radne škole, pokret jedinstvenih škola. „Svi nastali pokreti zalagali su se za: bitnost razvojne spoznaje za poučavanje i učenje; cjelovitost nastavnog procesa u smislu tretiranja svih učeničkih interesa i shvatanje nastave kao rada“ [7, str. 75]. Keršenštajner (Kerchensteiner) je u školama stvorio radionice, zbližio je poziv i školu. „Na temelju svoga kontakta s amerikancem Džonom Djujom naglašavao je razmišljanje pri radu. Polagao je veliku vrijednost na oblikovanje karaktera pri radu (samonadilaženje, istrajnost) i naglašavao vrijednost rada za strukovno obrazovanje“ [8, str. 86]. Dok rješava problem, učenik je u istraživačkom položaju, u kojem pokreće stvaralačko mišljenje, što podrazumijeva visoke nivoe stečenih znanja i usvojenih vještina, odnosno njegova koncepcija vaspitanja sažeta je u maksimi: „učenje kroz rad“ [9, str. 21]. Rješavanje problema jedan je od najviših oblika učenja. Iz ovog proizlazi da: Kompetencije koje učenici treba da posjeduju u obrazovnom sistemu u XXI vijeku u vezi su sa razvojem sposobnosti koje su odgovorne za iznalaženje adekvatnih strategija u rješavanju problema [10, str. 60].

METODOLOGIJA ISTRAŽIVANJA

Problem ovog istraživanja obuhvata inovativno učenje u nastavi matematike na mlađem školskom uzrastu učenika, te njegove efekte na znanja, vještine i rezultate na testovima iz brojevnih izraza sa više operacija.

Pretpostavlja se da učenici mlađeg školskog uzrasta koji su u početnoj nastavi matematike ovladali sadržajima primjenom inovacija postići viši nivo postignuća u rješavanju testova iz brojevnih izraza sa više operacija u odnosu na uobičajenu tradicionalnu nastavu.

Cilj istraživanja je utvrditi nivo vaspitno-obrazovnih postignuća učenika mlađeg školskog uzrasta koji su rezultat inovativnog pristupa u učenju.

Da bi se odgovorilo na tako postavljen cilj istraživanja, pristupilo se njegovoj konkretizaciji. Zadaci istraživanja:

- Provjeriti postignuća učenika mlađeg školskog uzrasta koji su u početnoj

nastavi matematike ovladali sadržajima primjenom inovativnog pristupa učenju u pogledu poznavanja brojevnih izraza sa više operacija.

- Utvrditi da li će učenici mlađeg školskog uzrasta koji su u početnoj nastavi matematike ovladali sadržajima primjenom inovativnog pristupa učenju postići statistički značajan nivo postignuća iz brojevnih izraza sa više operacija u odnosu na uobičajenu tradicionalnu nastavu.

Analiza obuhvata postignuća učenika iz početne nastave matematike iz tematske cjeline: Brojevi izrazi sa više operacija (tri testa).

Uzorak su činili učenici osam odjeljenja iz dvije osnovne škole sa područja grada Banja Luka (Osnovna škola „Ivo Andrić“ i Osnovna škola „Branko Ćopić“). U istraživanju su učestvovala po četiri odjeljenja iz navedenih škola. Po dva odjeljenja su činili eksperimentalnu i po dva odjeljenja kontrolnu grupu. Eksperimentalna i kontrolna grupa su posmatrane kao cjeline i u okviru njih je bilo po 95 učenika.

Uspjeh učenika iz Brojevnih izraza sa više operacija mjenen je tri puta pomoću tri testa:

- Tradicionalni test Brojevnih izraza sa više operacija,
- Test sa zadacima tri nivoa složenosti Brojevnih izraza sa više operacija i
- Test sa problemskim zadacima o Brojevnim izrazima sa više operacija.

Prvi test iz Brojevnih izraza sa više operacija sadržao je 6 zadataka i bio je to tradicionalni test, u poređenju sa narednim testovima koji će biti primijenjeni i najmanje zahtjevan test. Svi zadaci se odnose na Brojeve izraze sa sabiranjem, oduzimanjem, množenjem i dijeljenjem. U pojedinim zadacima izrazi su zapisivani sa zagradama, zadani su izrazi sa dvije i tri računke operacije gdje je trebalo ispoštovati redosljed računskih operacija. U ovom testu učenici nisu imali niti jedan zadatak tekstualnog tipa na osnovu kojeg je trebalo postaviti matematički izraz. Test je sadržao dva pitanja u kojima je trebalo navesti informaciju o sabiranju i oduzimanju i u jednom zadatku opisati pravilo poštovanja zagrada.

REZULTATI I DISKUSIJA

U Tabeli 1. prikazani su podaci o postignuću učenika, odnosno inicijalnom mjerenju tradicionalnim testom znanja iz Brojevnih izraza sa više operacija u odnosu na grupu.

Tabela 1. Prvo mjerenje uspjeha na testu iz Brojevnih izraza sa više operacija tradicionalnim testom u odnosu na grupu

Grupa	N	M	SD	t - test	df	Sig.
K	95	11,20	4,39	-1,68	188	0,094
E	95	12,15	3,30			

Prema podacima prikazanim u prethodnoj tabeli uočava se da su učenici kontrolne i eksperimentalne grupe na prvom mjerenju, prvim tradicionalnim testom znanja iz Brojevnih izraza sa više operacija ostvarili slična postignuća. Aritmetičke sredine se ne razlikuju mnogo. Pozitivno je to što su učenici eksperimentalne grupe ostvarili veću aritmetičku sredinu ($M = 12,15$) i što su njihova znanja homogenija (manja je standardna devijacija od učenika kontrolne grupe, $SD = 3,30$). Prema statističkim

pokazateljima ($t = -1,68$, $df = 188$ i $Sig. 0,094$) nije utvđena statistički značajna razlika na prvom mjerenju prvim testom.

Drugi test je test sa zadacima na tri nivoa složenosti i sadrži 6 zadataka. Svaki nivo sadržao je po dva zadatka. Prvi, najlakši nivo u prvom pitanju, je imao ponuđen odgovor da se sa zaokruživanjem konstatuje da li je rečenički iskaz tačan ili netačan. Drugi zadatak se odnosio na izračunavanje vrijednosti izraza samo sa sabiranjem i oduzimanjem i bez zagrada. U drugom nivou

prvi zadatak je bio da se izračuna vrijednost izraza sa tri operacije, uz napomenu da se vodi računa o redosljedu računskih operacija. Drugi zadatak se odnosio na opisivanje redosljeda računskih radnji u brojevnim izrazima. Prvi zadatak u trećem nivou je bio tekstualno zapisan zadatak, gdje su učenici trebali da prvo sastave matematički izraz, a zatim da poštujući redosljed računskih operacija

izračunaju vrijednost izraza. Drugi zadatak u trećem nivou je bio najteži, sadržao je tri primjera u obliku tekstualnih zadataka.

U Tabeli 2. prikazani su podaci o postignuću učenika na mjerenju tradicionalnim testom znanja iz Brojevnih izraza sa više operacija na tri nivoa složenosti u odnosu na grupu.

Tabela 2. Drugo mjerenje uspjeha na testu iz Brojevnih izraza sa više operacija testom na tri nivoa složenosti u odnosu na grupu

Grupa	N	M	SD	t - test	df	Sig.
K	95	10,85	3,98	-2,63	188	0,009**
E	95	12,23	3,20			

**Utvrđena statistički značajna razlika na nivou 0,01

Na osnovu podataka prikazanih u prethodnoj tabeli uočava se da se postignuća učenika kontrolne i eksperimentalne grupe na prvom mjerenju, drugim testom znanja iz Brojevnih izraza sa više operacija na tri nivoa složenosti razlikuju. Aritmetička sredina eksperimentalne grupe je veća ($M = 12,23$) od učenika kontrolne grupe ($M = 10,85$). Pozitivno je i to što su znanja učenika eksperimentalne grupe homogenija u odnosu na znanja kontrolne grupe. Prema statističkim pokazateljima ($t = -2,63$, $df = 188$ i $Sig. 0,009$) utvrđena je statistički značajna razlika na prvom mjerenju drugim testom na nivou 0,01. Dakle, učenici eksperimentalne grupe imaju statistički značajno veće postignuće iz poznavanja Brojevnih izraza sa više operacija od učenika kontrolne grupe. Ova postignuća

pripisujemo nešto dužem periodu djelovanja eksperimentalnog programa, odnosno vježbanju na različitim nivoima složenosti kojeg u kontrolnoj grupi nije bilo.

Treći test sa problemskim zadacima sadržao je 6 zadataka. U odnosu na prethodna dva testa ovo je najteži test. Svi zadaci su tekstualnog tipa, gdje se razumijevanjem teksta treba postaviti matematički izraz i izračunati njegova vrijednost. Najteži zadatak je imao tri primjera i u sva tri primjera učenici su trebali da sastave tekstualni zadatak (problem).

U Tabeli 3. prikazani su podaci o postignuću učenika na prvom mjerenju problemskim testom znanja iz Brojevnih izraza sa više operacija u odnosu na grupu.

Tabela 3. Treće mjerenje uspjeha na testu iz Brojevnih izraza sa više operacija testom sa problemskim zadacima u odnosu na grupu

Grupa	N	M	SD	t - test	df	Sig.
K	95	10,79	3,91	-2,34	188	0,020*
E	95	12,17	4,21			

*Utvrđena statistički značajna razlika na nivou 0,05

Prema podacima prikazanim u Tabeli 3. vidljivo je da se postignuća učenika kontrolne i eksperimentalne grupe na prvom finalnom mjerenju, trećim problemskim testom znanja iz Brojevnih izraza sa više operacija razlikuju. Aritmetička sredina eksperimentalne grupe je

veća ($M = 12,17$) od učenika kontrolne grupe ($M = 10,79$). Interesantno je to što su znanja učenika eksperimentalne grupe manje homogena u odnosu na znanja kontrolne grupe. Prema statističkim pokazateljima ($t = -2,34$, $df = 188$ i $Sig. 0,020$) utvrđena je

statistički značajna razlika na prvom mjerenju trećim testom na nivou 0,05. Dakle, učenici eksperimentalne grupe imaju statistički značajno veće postignuće iz poznavanja Brojevnih izraza sa više operacija od učenika kontrolne grupe. Takođe, ova postignuća pripisujemo nešto dužem periodu djelovanja eksperimentalnog programa, posebno većem broju časova vježbanja.

Nakon mjerenja sa tri različito strukturisana testa bilo bi poželjno izvršiti i analizu postignuća između grupa međusobno, kao i između postignuća različitih testova međusobno. Ta analiza nije moguća jer se ne radi o istim mjernim skalama, odnosno maksimalni skor i broj bodova po zadacima u okviru tri različita testa nije bio isti.

ZAKLJUČCI

Učenici eksperimentalne grupe u odnosu na učenike kontrolne grupe su na mjerenju ostvarili **na prvom testu**: veća aritmetička sredina iz znanja o Brojevnim izrazima sa više operacija, mjereno tradicionalnim testom; **na drugom testu**: statistički značajno veći nivo znanja o Brojevnim izrazima sa više operacija na nivou 0,01, mjereno testom na tri nivoa složenosti; **na trećem testu**: statistički značajno veći nivo znanja o Brojevnim izrazima sa više operacija na nivou 0,05, mjereno problemskim testom.

Utvrđeni rezultati idu u prilog pozitivnog uticaja eksperimentalnog programa. Nakon primjene eksperimentalnog programa, odnosno inovativnog učenja u početnoj nastavi matematike sa ostvarenim postignućima i efektima učenja treba biti zadovoljan. Iz ovog zaključujemo: Matematika je jedan od predmeta koji ima važnu ulogu u obrazovanju [11, str 13], a što se tiče teorijskih polazišta u početnoj nastavi matematike, Pijaže [12] smatra da su za razmatranje problema relevantna istraživanja. Cjelovitost nastavnog procesa je u smislu tretiranja svih učeničkih interesa i „shvatanje nastave kao rada” [7, str. 75]. Novi modeli i vidovi učenja u početnoj nastavi matematike moraju se dobro osmisliti i funkcionalno koristiti. Takva praksa zahtijeva i odgovarajuću inicijalnu obuku pozivajući na promjene u programima obrazovanja ([13, str. 9040].

Na osnovu ovoga dolazimo do zaključka: „Znanje da se riješi efikasan zadatak predstavlja najbolju karakteristiku u svijetu” [14, str. 297]. „Iako je kreativno nadahnuće apsolutno nužno, također je važno razumjeti da inovativne ideje moraju biti i praktične” [15, str. 1127], a to svjedoče prikazani ključni nalazi ovog rada koji ukazuju na činjenicu da je između učenika eksperimentalne i učenika kontrolne grupe utvrđena statistički značajna razlika u korist učenika eksperimentalne grupe i mogu biti snažna inspiracija i poslužiti kao model za koncipiranje novih i sadržajnih metodoloških pristupa.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURA

1. Horvat, Z. (2019). *Didaktičko-metodičke kompetencije nastavnika matematike*. Doktorska disertacija. Zagreb: Sveučilište u Zagrebu, Filozofski fakultet.
2. Horvat, Z. (2018). Motivacija u suvremenoj nastavi matematike. *Poučak: časopis za metodiku i nastavu matematike*, 19(73), 21-28.
3. Đukić, M. (1995). *Didaktički činioci individualizovane nastave*. Novi Sad: Filozofski fakultet.
4. Veinović, Z. (2004). Savremene teorije učenja i nastave i problemska nastava. *Obrazovna tehnologija*, 4, 59-66.
5. Zihler, B. (2006). Individualizovana nastava u muzičkoj kulturi. *Obrazovna tehnologija*, 1, 56-63.
6. Dumbović, I., & Protner, E. (2005). *Pedagozi značajni za praksu i teoriju odgoja: enciklopedija*. Hrvatska: n.p. ISBN: 9789537321000.
7. Pranjić, M. (2004). *Didaktika: povijest, osnove, profiliranje, postupak*. Zagreb: Golden marketing-Tehnička knjiga.
8. Gudjons, H. (1993). *Pedagogija temeljna znanja*. Zagreb: Educa.
9. Dewey, J. (2004). *Liberalizam i društvena akcija*. Zagreb: KruZak.
10. Kurniawan, H. (2016). Efektifitas pembelajaran problem solving dan

- investigasi terhadap keterampilan berpikir kritis matematis berbantuan Google Classroom. *Jurnal Pendidikan Surya Edukasi (JPSE)*, 2(1), 56–67.
11. Muhtadi, D., Kartasmita, B. G., & Prahmana, R. C. I. (2017). The Integration of technology in teaching mathematics. In *Journal of Physics: Conference Series* 943(1), 012020. IOP Publishing.
12. Pijaž, Ž. i Inhelder, B. (1978). *Intelektualni razvoj deteta*. Beograd: Zavod za udžbenike i nastavna sredstva.
13. Cazzola, M. (2018). Problem-Based Learning and Teacher Training in Mathematics: How to Design a Math Laboratory. In *INTED2018 Proceedings* (pp. 9038-9043). IATED [10.21125/inted.2018].
14. Ati, T. P., & Setiawan, Y. (2020). Efektivitas problem based learning-problem solving terhadap kemampuan berpikir kritis dalam pembelajaran matematika siswa kelas V. *Jurnal Cendekia*, 4(1), 294-303.
15. Mouzas, S. (2006). Efficiency versus Effectiveness in Business Networks. *Journal of Business Research*, 59, 1124-1132.

STUDENT ACHIEVEMENT IN NUMERICAL EXPRESSIONS WITH MULTIPLE OPERATIONS

Slađana Lolić

University of Banja Luka, Faculty of Philosophy, Bulevar vojvode Petra Bojovića 1A, 78 000 Banja Luka, Bosnia and Herzegovina, lolics537@gmail.com

ORIGINAL SCIENTIFIC PAPER

ISSN 2637-2150

e-ISSN 2637-2614

DOI 10.63395/STEDJournal0702079L1

UDC 159.954/.956-057.874:37.081.315.7

COBISS.RS-ID 143555585

Received: 08 July 2025.

Revised: 16 July 2025.

Accepted: 16 July 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Corresponding author:

Slađana Lolić, Univerzitet u Banjoj Luci, Filozofski fakultet, Bulevar vojvode Petra Bojovića 1A, 78 000 Banja Luka, Bosna i Hercegovina, lolics537@gmail.com



Copyright © 2025 Slađana Lolić; published by UNIVERSITY PIM. This work licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.

Citation: Lolić, S. (2025). Postignuća učenika iz brojevnih izraza sa više operacija. *STED Journal*, 7(2), 1-7.

ABSTRACT

Learning is a value for every student, for every school, for parents, teachers and for society as a whole. Numerous studies show that educational effects can be achieved in traditional (frontal) teaching, but the results of experimental research in most cases show that under the influence of innovations and modern strategies, methods and procedures, educational achievements are more easily achieved, which can be viewed comprehensively in the context of research outcomes related to both education and upbringing. The application of new approaches in learning leads to the development of students' creative thinking, the teaching process becomes more creative. The aim of this paper is to determine the level of achievement of students solving mathematical problems from Numerical Expressions by applying problems by levels of complexity, problem solving of problems and the traditional way of solving problems.

Keywords: traditional learning, learning by applying tasks according to levels of complexity, problem-based teaching.

EFFECT OF SELECTED PLANT SPECIES ON THE ANTIOXIDANT AND ANTIMICROBIAL PROPERTIES OF JANJ CHEESE

Danica Savanović¹, Ana Velemir¹, Aleksandar Savić¹, Ljiljana Topalić Trivunović¹, Jovo Savanović², Vesna Muždeka¹

¹University of Banja Luka, Faculty of Technology Banja Luka, Vojvode Stepe Stepanovića 73, 78000 Banja Luka, Bosnia and Herzegovina, danica.savanovic@tf.unibl.org

²Higher school "Banja Luka College", Banja Luka, Miloša Obilića 30, 78000 Banja Luka, B&H

ORIGINAL SCIENTIFIC PAPER

ISSN 2637-2150

e-ISSN 2637-2614

DOI 10.63395/STEDJournal0702081S8

UDC 637.1/.3:547.458.88

COBISS.RS-ID 143558657

Received: 12 July 2025.

Revised: 26 August 2025.

Accepted: 19 August 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Corresponding Author: Danica Savanović, University of Banja Luka, Faculty of Technology Banja Luka, Vojvode Stepe Stepanovića 73, 78000 Banja Luka, Bosnia and Herzegovina, danica.savanovic@tf.unibl.org



Copyright © 2024 Danica Savanović, et al.; published by UNIVERSITY PIM. This work licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.

Citation: Savanović, D. et al. (2025). Effect of selected plant species on the antioxidant and antimicrobial properties of Janj cheese. *STED Journal*, 7(2), 8-19.

<https://doi.org/10.63395/STEDJournal0702081S8>

ABSTRACT

This study examined the effect of adding selected plant species on the antioxidant and antimicrobial properties of Janj cheese. Twelve cheese samples were prepared in two batches, each including one control sample and five samples enriched with oregano

(*Origanum vulgare*), basil (*Ocimum basilicum*), parsley (*Petroselinum crispum*), rosemary (*Rosmarinus officinalis*), and chives (*Allium schoenoprasum*). The first batch contained 0.50%, while the second batch had 1.00% concentrations of the plants. Total phenols, flavonoids, and non-flavonoid compounds were measured. Antioxidant activity was assessed through FRAP, DPPH, and ABTS assays. Antimicrobial activity was evaluated using the agar dilution method against four bacterial strains (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus cereus*) and two *Candida albicans* strains. The results revealed a statistically significant increase ($p < 0.05$) in antioxidant activity in the plant-enriched cheese samples, emphasizing their potential as natural sources of antioxidants. However, none of the cheeses showed antimicrobial activity under the tested conditions. In conclusion, the incorporation of these selected plant species improves the biological and functional properties of Janj cheese, supporting its potential as a nutritionally enhanced product.

Keywords: plant species, Janj cheese, antioxidant properties, antimicrobial properties.

INTRODUCTION

Cheese is a dairy product obtained by coagulating milk and separating whey. It can be made from various types of milk or dairy ingredients and is a rich source of high-quality proteins, essential amino acids, calcium, and fat-soluble vitamins [1], [2], [3], [4].

In both the dairy industry and gastronomy, traditional cheeses are valued for their use of local raw materials and artisanal production methods passed down through generations. These products preserve authentic

sensory characteristics and microbial diversity, thereby supporting rural communities and local economies [5]. Typically produced from raw milk and natural starters, traditional cheeses develop complex microbial communities that differ markedly from those found in industrially produced cheeses [6]. Beyond their sensory appeal, they may provide functional benefits due to the presence of beneficial microbes and bioactive compounds with antioxidant and antimicrobial activities [5], [7]. Owing to their authenticity and geographical origin, traditional cheeses are often protected by geographical indications and quality labels, which enhance their market visibility and promote sustainable production practices [5], [8].

Among the traditional cheeses of Bosnia and Herzegovina, *Janj cheese* is particularly notable for its distinctive flavor and traditional handmade production. This cheese originates from the mountainous region along the Janj River, in western Bosnia (Šipovo municipality, Republika Srpska). It is primarily made from cow's milk, either raw or mildly heat-treated, without the addition of commercial starter cultures, allowing the development of a natural microflora that contributes to the unique sensory attributes of the cheese [9].

Many plants are rich in secondary metabolites such as phenolic compounds, flavonoids, terpenoids, alkaloids, and essential oils, which exhibit significant biological activities and have wide-ranging applications in nutrition and health. Phenolic compounds, in particular, are recognized for their strong antioxidant potential [10], while terpenoids and essential oils function as natural antimicrobial and antioxidant agents [11], [12]. Alkaloids also demonstrate antimicrobial activity, especially against antibiotic-resistant bacteria [13]. These bioactive compounds are increasingly used as natural preservatives in the food, cosmetic, and pharmaceutical industries, offering safer alternatives to synthetic additives [14], [15], [16], [17].

Enriching cheese with selected plants can enhance its antioxidant and antimicrobial properties, thereby extending shelf life and improving sensory characteristics [18], [19]. Plants such as oregano, rosemary, and garlic

act as natural preservatives, reducing the need for synthetic additives [11], [14], [20]. Such functionally enriched cheeses preserve the authenticity of traditional products while providing added health benefits to consumers [2], [3], [5]. Antioxidants neutralize free radicals and reactive oxygen species, thereby preventing oxidative stress linked to chronic diseases [21]. Plants such as rosemary, oregano, thyme, and basil are rich in phenolic compounds that confer potent antioxidant protection [12]. Rosemary extract, for instance, exhibits high free radical scavenging capacity [22], while oregano and thyme, and basil are effective in preventing lipid oxidation in foods [18], [23].

Additionally, plant extracts exert antimicrobial effects through active compounds such as carvacrol and thymol from oregano and thyme, which disrupt bacterial membranes and cause cell death [11], [24]. Allicin, the major bioactive compound in garlic, exerts a bactericidal effect by inducing oxidative stress and interfering with protein synthesis in bacterial cells [20]. Owing to these properties, plant extracts are being extensively studied as natural preservatives and potential ingredients in functional foods and phytopharmaceuticals [11], [25], [26]. The aim of this study was to evaluate the influence of selected plant species on antioxidant and antimicrobial **properties** of Janj cheese.

MATERIAL AND METHODS

The samples of Janj cheese were produced at a rural household in Lipovača near Šipovo, with a long tradition in producing milk, Janj cream, and Janj braided cheese. Analyses were conducted at the Laboratory for Food Technologies and the Laboratory for Instrumental Analyses at the Faculty of Technology, University of Banja Luka. Twelve samples were produced for this study, divided into two batches of six each. Each batch included one control sample without plant addition. The remaining five samples in each batch contained oregano (*Origanum vulgare*), basil (*Ocimum basilicum*), parsley (*Petroselinum crispum*), rosemary (*Rosmarinus officinalis*), and chives (*Allium schoenoprasum*), added at concentrations of 0.50% in the first batch and 1.00% in the

second (Table 1). The production process was partially modified, the cheese was shaped not into the traditional braid form but into rolled forms. For each batch, 30 L of milk was used. After the evening milking, the milk was strained, covered with a cloth, and left at room temperature for 14 hours. The readiness of the milk for coagulation was verified by heating 100 mL of milk until curdling and whey separation occurred. The milk was then heated to 38 °C, and 60 mL of rennet (2.00% of the milk volume) was added. After incubation at this temperature for 20 minutes, the temperature was raised to 50 °C. The curd was gently stirred with a spoon for 10 minutes to

facilitate cutting, then manually pressed against the sides of the container for an additional 10 minutes to expel the whey. At this stage, the whey temperature was 48 °C. The cheese mass was subsequently separated, weighed to 500 g, and stretched to a thickness of 1 cm. The surface was sprinkled with 1.50% salt and plant species at concentrations of 0.50% for the first batch and 1.00% for the second batch. The finished cheeses were placed on an inclined surface for 30 minutes to allow excess whey to drain, after which they were wrapped in plastic foil and stored at +4 °C until analysis.

Table 1. Plant species and their concentrations (%) in Janj cheese samples

Batch	Control	<i>Origanum vulgare</i> (%)	<i>Ocimum basilicum</i> (%)	<i>Petroselinum crispum</i> (%)	<i>Rosmarinus officinalis</i> (%)	<i>Allium schoenoprasum</i> (%)
1	-	0.50	0.50	0.50	0.50	0.50
2	-	1.00	1.00	1.00	1.00	1.00

Phenolic content and antioxidant activity analyses were performed exclusively on the cheese samples, while antimicrobial activity was evaluated on both the cheese samples and the plant species used during production. For analysis, 80% ethanol extracts of plant species and cheeses were prepared.

The total phenolic content (TPC) was determined spectrophotometrically using a modified Folin-Ciocalteu method [27], based on the colorimetric reaction of phenolic compounds with the Folin-Ciocalteu reagent and the measurement of the resulting color intensity at 765 nm. The non-flavonoid content (TNF) was determined using the formaldehyde precipitation method [28]. The flavonoid content (TF) was calculated as the difference between the total phenolic and non-flavonoid content. Results were expressed as micrograms of gallic acid equivalents per gram of sample (µg GAE/g). Antioxidant activity was evaluated using DPPH, ABTS⁺, and FRAP assays. The DPPH assay measures the reduction of the violet DPPH radical (λ = 517 nm) to the yellow DPPH-H by antioxidants [29]. The ABTS⁺ assay involves decolorization of the ABTS⁺ radical (λ = 734 nm) generated by potassium persulfate [30]. Trolox was used as a standard, and results are

expressed as micromoles of Trolox equivalents per gram (µmol TE/g). The FRAP assay [31] is based on the reduction of the Fe³⁺-TPTZ complex to Fe²⁺-TPTZ, measured by the intensity of the blue color formed under acidic conditions. All data were analyzed using Microsoft Excel 2013 and IBM SPSS Statistics 22.0. Results are presented as mean ± SD from three samples. Statistical differences were evaluated by one-way ANOVA with Tukey's HSD post-hoc test. Significance was set at p < 0.05.

To determine the antibacterial and antifungal activity of the plant species and cheese extracts, the agar dilution method was used to obtain the minimum inhibitory concentrations (MIC) and minimum bactericidal (MBC) or fungicidal (MFC) concentrations [32], [33], [34]. The final concentrations of the extracts in the medium were: 5, 2.5, 1.25, 0.625, and 0.213 mg/mL. The extracts were tested against four bacterial strains: *Escherichia coli* WDCM 00013, *Pseudomonas aeruginosa* WDCM 00024, *Staphylococcus aureus* WDCM 00034, *Bacillus cereus* WDCM 00151, and two fungal strains: *Candida albicans* WDCM 00054 and a *Candida albicans* clinical isolate.

RESULTS AND DISCUSSION

The analysis of total phenol content (TPC), non-flavonoid compounds (TNF), and flavonoids (TF) in Janj cheese samples enriched with different plant species revealed significant differences depending on the type and concentration of the added plant species ($p < 0.05$) (Table 2).

In both test **batches** (0.50% and 1.00%), the control samples, without any plant species, had the lowest values of total phenols. In the first **batch**, TPC amounted to 485.22 $\mu\text{g GAE/g}$, and in the second, 511.69 $\mu\text{g GAE/g}$, which corresponds to the baseline phenolic profile of cheese without the influence of plant species. Josipović et al. [35] reported that the total phenol content in fresh cheese (cottage) is approximately 21 $\mu\text{g/g}$, but increases significantly with the addition of plant *species* up to 284 $\mu\text{g/g}$ with 0.50% dried parsley and 345 $\mu\text{g/g}$ with 1% dried rosemary.

The highest total phenol content in the tested samples of Janj cheese was recorded in samples with the addition of oregano (*Origanum vulgare*), significantly exceeding ($p < 0.05$) the values observed for other plant species, with 990.89 $\mu\text{g GAE/g}$ at 0.50% and 1303.17 $\mu\text{g GAE/g}$ at 1.00% addition. This finding confirms numerous previous studies that have shown oregano to possess a remarkably high content of phenolic compounds, particularly thymol and carvacrol, which exhibit strong antioxidant and antimicrobial properties [36], [37], [38], [39]. Similar studies have demonstrated that oregano not only enhances the antioxidant capacity of foods but may also prolong shelf life due to its antimicrobial activity [14]. The phenol content in samples with rosemary (*Rosmarinus officinalis*) was also considerable, with values of 662.85 $\mu\text{g GAE/g}$ (0.50%) and 1003.28 $\mu\text{g GAE/g}$ (1.00%). This is consistent with the findings of Petersen and Simmonds [40], who identified rosmarinic and carnosic acids as the main phenolic components in rosemary with pronounced antioxidant properties. Rosemary is known for protecting lipids in foods from oxidation [22], [41], which is an important factor in the dairy industry where lipid oxidation is a frequent issue [42]. Samples with parsley (*Petroselinum crispum*) and basil (*Ocimum*

basilicum) also showed a notable increase in phenolic compounds compared to the control, although with lower values than oregano and rosemary. According to studies by El-Sayed et al. [43], parsley contains numerous phenolic compounds that contribute to antioxidant activity, while Qamar et al. [44] noted that basil contains significant amounts of flavonoids and other phenols that influence overall antioxidant capacity. Chives (*Allium schoenoprasum*) had the lowest phenol content compared to the other tested plants, which is consistent with the data presented by Todorović et al. [37], who reported the lowest phenolic values for chives.

The content of non-flavonoid phenols (TNF) in samples with plant additions was significantly increased ($p < 0.05$) compared to the control, indicating the presence of various phenolic acids, tannins, and other polyphenols that, although not flavonoids, play an important role in antioxidant mechanisms [45].

Flavonoids (TF) also represent a significant portion of total phenols, with the highest values ($p < 0.05$) found in samples with oregano, which aligns with findings by Heim et al. [46], who emphasized the importance of flavonoids as some of the most potent natural antioxidants.

The increase in phenol concentration, and consequently enhanced antioxidant properties in cheese with the addition of plant species, indicates the potential of these natural additives to improve the quality of dairy products. Such

enrichment not only enhances the health-related aspects of cheese but can also contribute to extending its freshness and safety, as antioxidants slow down lipid oxidation and the development of microorganisms [26], [38].

The statistically significant differences between samples in all parameters ($p < 0.05$) confirm the relevance of the type of plant and the concentration of its addition in influencing the phenolic composition of cheese. Furthermore, the increase in phenol content was proportional to the amount of additive, indicating the possibility of controlling antioxidant levels in products as needed. Enriching Janj cheese with oregano, rosemary,

Savanović, D. et al. (2025). Effect of selected plant species on the antioxidant and antimicrobial properties of Janj cheese. *STED Journal*, 7(2), 8-19.

parsley, basil, and chives represents an effective approach to enhancing its biological properties and functional capacity, in line with

the global trend of using natural additives in the food industry.

Table 2. Content of total phenols (TPC), non-flavonoids (TNF), flavonoids (TF) in the tested cheese samples

Plant species	Batch 1 (0.50%)			Batch 2 (1.00%)		
	TPC ($\mu\text{g GAE/g}$)	TNF ($\mu\text{g GAE/g}$)	TF ($\mu\text{g GAE/g}$)	TPC ($\mu\text{g GAE/g}$)	TNF ($\mu\text{g GAE/g}$)	TF ($\mu\text{g GAE/g}$)
-	485.22 ^a ± 0.28	342.93 ^a ± 3.01	142.29 ^b ± 3.29	511.69 ^a ± 8.68	359.29 ^a ± 4.00	152.40 ^a ± 4.68
<i>Origanum vulgare</i>	990.89 ^c ± 8.99	714.54 ^c ± 5.68	276.36 ^c ± 8.97	1303.17 ^d ± 9.28	994.49 ^f ± 6.05	308.68 ^e ± 3.24
<i>Ocimum basilicum</i>	593.50 ^c ± 3.41	399.67 ^b ± 2.59	193.83 ^d ± 0.82	886.08 ^b ± 9.98	689.78 ^c ± 63.46	196.30 ^c ± 3.51
<i>Petroselinum crispum</i>	591.22 ^c ± 6.72	429.07 ^c ± 2.17	162.15 ^c ± 4.55	992.73 ^c ± 4.09	761.04 ^d ± 6.27	231.70 ^d ± 2.18
<i>Rosmarinus officinalis</i>	662.85 ^d ± 0.98	472.31 ^d ± 6.80	190.53 ^d ± 5.82	1003.28 ^c ± 9.06	838.60 ^e ± 5.64	164.68 ^b ± 3.42
<i>Allium</i>	555.64 ^b ± 7.14	427.31 ^c ± 4.43	128.33 ^a ± 3.09	874.66 ^b ± 7.91	672.60 ^b ± 5.72	202.06 ^c ± 2.19
<i>schoenoprasum</i>						

a-e mean values with different letters in the same column are statistically significantly different with 95% probability ($p < 0.05$)

The results presented in Table 3 indicate that the addition of selected plant species significantly influences the antioxidant activity of Janj cheese compared to the control sample ($p < 0.05$). A trend of increased activity was also observed with the rise in plant concentration from 0.50% to 1.00%. Control samples exhibited low but detectable antioxidant activity, likely due to natural milk components such as proteins (e.g., casein) and vitamins A and E, which possess free radical scavenging abilities [47]. The control sample, without the addition of plant species, showed the lowest values across all tested methods (FRAP: 0.36–0.31 $\mu\text{molFe}^{2+}/\text{g}$; DPPH: 70.92–77.44 $\mu\text{MTE/g}$; ABTS: 185.53–193.40 $\mu\text{MTE/g}$), confirming the limited natural antioxidant capacity of the cheese itself. Cheese enriched with oregano (*Origanum vulgare*) exhibited the highest antioxidant activity in all evaluated parameters (FRAP, DPPH, and ABTS). FRAP values increased from 2.10 $\mu\text{molFe}^{2+}/\text{g}$ in batch 1 to 2.96 $\mu\text{molFe}^{2+}/\text{g}$ in batch 2. In parallel, DPPH and ABTS values significantly increased, reaching 703.59 $\mu\text{MTE/g}$ and 1704.98 $\mu\text{MTE/g}$, respectively, in batch 2. These results demonstrate the exceptionally strong radical-scavenging capacity of oregano, which is consistent with previous findings confirming its high content of phenolic compounds,

especially carvacrol and thymol [48], [49], [50]. Their presence in oregano-enriched cheese contributes significantly to the overall increase in antioxidant activity. Rosemary (*Rosmarinus officinalis*) followed oregano in antioxidant potential. In cheese samples containing 1.00% rosemary, the FRAP value reached 1.94 $\mu\text{molFe}^{2+}/\text{g}$, while DPPH and ABTS activities were 553.98 $\mu\text{MTE/g}$ and 988.52 $\mu\text{MTE/g}$, respectively. Rosemary is rich in rosmarinic acid, carnosol, and carnosic acid, which are potent natural antioxidants commonly used to protect fats in food products [22]. The addition of basil (*Ocimum basilicum*) and parsley (*Petroselinum crispum*) also resulted in an increase in antioxidant activity compared to the control sample, although to a lesser extent than oregano-enriched cheese. In batch 2, basil-enriched samples had a FRAP value of 1.45 $\mu\text{molFe}^{2+}/\text{g}$, while DPPH and ABTS values were 275.53 $\mu\text{MTE/g}$ and 577.12 $\mu\text{MTE/g}$, respectively. Parsley showed slightly lower values but still significantly improved the antioxidant profile of the cheese compared to the control. These plants are rich in flavonoids such as apigenin and luteolin, which contribute to their antioxidant activity [51], [52]. The lowest values for most tested antioxidant activity parameters were recorded in samples enriched with chives (*Allium*

schoenoprasum), although statistically significant differences ($p < 0.05$) were still observed in comparison to the control. Increasing the concentration from 0.50% to 1.00% resulted in a slight increase in activity, indicating an effect of the higher additive amount. Although chives are known to contain numerous bioactive compounds, including phenolic and sulfur-containing compounds [53], [54], their overall radical-neutralizing capacity may be reduced in complex matrices such as plant-enriched cheese.

A strong correlation between total polyphenol content and antioxidant activity of plant extracts and additives has been previously confirmed [31], [55]. Djeridane et al. [56] demonstrated that extracts from phenolic-rich plants exhibit significant antioxidant activity as measured by DPPH and

FRAP assays, highlighting the key role of polyphenols in neutralizing free radicals. Prior et al. [55] emphasized the importance of standardized methods for evaluating this relationship in foods and supplements, while Benzie and Strain [31] developed the FRAP methodology, which is widely accepted for assessing antioxidant power and showed that total phenols contribute significantly to such activity. This relationship is also confirmed in the present study, where the increase in total phenols in cheese enriched with plant species was followed by a clear rise in antioxidant activity. This further underscores the importance of phenolic compounds in enhancing the biological properties of food, particularly in products such as cheese, where oxidative processes can negatively impact quality, safety, and shelf life.

Table 3. Antioxidant activity (FRAP, DPPH, ABTS) of Janj cheese samples with added plant species at concentrations of 0.50% and 1.00%

Plant species	Batch 1 (0.50%)			Batch 2 (1.00%)		
	FRAP ($\mu\text{molFe}^{2+}/\text{g}$)	DPPH ($\mu\text{MTE}/\text{g}$)	ABTS ($\mu\text{MTE}/\text{g}$)	FRAP ($\mu\text{molFe}^{2+}/\text{g}$)	DPPH ($\mu\text{MTE}/\text{g}$)	ABTS ($\mu\text{MTE}/\text{g}$)
-	0.36 ^a ±0.00	70.92 ^a ±5.20	185.53 ^a ±9.62	0.31 ^a ±0.01	77.44 ^a ±4.41	193.40 ^a ±9.17
<i>Origanum vulgare</i>	2.10 ^e ±0.02	436.19 ^e ±8.94	1181.03 ^e ±5.60	2.96 ^e ±0.04	703.59 ^f ±7.78	1704.98 ^e ±9.02
<i>Ocimum basilicum</i>	0.65 ^c ±0.02	101.31 ^c ±5.83	451.56 ^c ±5.56	1.45 ^c ±0.01	275.53 ^d ±6.77	577.12 ^c ±8.60
<i>Petroselinum crispum</i>	0.52 ^b ±0.01	94.83 ^{b,c} ±2.90	411.65 ^b ±8.39	0.95 ^b ±0.08	245.85 ^c ±7.34	525.98 ^b ±9.74
<i>Rosmarinus officinalis</i>	1.51 ^d ±0.06	373.63 ^d ±8.74	708.93 ^d ±3.45	1.94 ^d ±0.08	553.98 ^e ±2.81	988.52 ^d ±6.58
<i>Allium schoenoprasum</i>	0.48 ^b ±0.08	83.62 ^b ±2.23	441.50 ^c ±3.34	0.96 ^b ±0.08	224.41 ^b ±2.03	534.78 ^b ±5.89

a-e mean values with different letters in the same column are statistically significantly different with 95% probability ($p < 0.05$)

The analysis of the obtained results clearly indicates that the addition of selected plant species significantly contributes to the increase in the antioxidant activity of the examined Janj cheese samples. Cheese samples with a higher percentage of plant species exhibited greater antioxidant capacity compared to those with lower concentrations of the same plants, suggesting a dose-dependent effect. The control samples, without the presence of plants, demonstrated the lowest antioxidant activity values, thereby confirming the essential role of plant addition in enhancing the biochemical properties of

cheese. In addition to improving antioxidant potential, the spices could have a positive impact on the sensory characteristics of the product [18], [35], further supporting their application in the production process. Based on these findings, the use of plants as natural additives is recommended for improving the functional and sensory properties of cheese, as well as enhancing the overall quality of the product.

Extracts from cheeses enriched with 1% plant species did not exhibit antimicrobial activity against the tested microorganisms under the applied experimental conditions.

Although previous studies, such as that by Zhong et al. [57], indicated a possible synergistic effect of low concentrations of bioactive compounds, especially when compounds of similar polar nature are present simultaneously, the results in this study suggest that the concentrations of active substances in the cheese did not reach the threshold required to express inhibitory effects. The absence of antimicrobial activity may be due to the diluting effect of the complex cheese matrix, which reduces the availability and stability of active components, as well as possible changes in their bioactivity during production and maturation processes. Therefore, additional analyses were conducted on the plant species themselves, independently of the cheese matrix, to determine their inherent antimicrobial activity. This approach aimed to clarify whether the plants, in the

absence of complex interactions within the dairy product, possess the potential to inhibit the growth of selected microorganisms. These findings highlight the need for further research focused on optimizing formulations, such as the application of higher concentrations of plant species, microencapsulation, or the use of carriers, in order to increase the efficacy of bioactive compounds in dairy products.

The best antibacterial activity was demonstrated by oregano and rosemary extracts, which showed the lowest minimum inhibitory concentrations (MIC) against Gram-positive bacteria *Bacillus cereus* and *Staphylococcus aureus* (Table 4). These results indicate the potential of these plants as natural antibacterial agents, highlighting their possible application in food preservation and safety.

Table 4. Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of ethanol extracts of selected plant species

Plant species	<i>E. coli</i> WDCM 00013		<i>P. aerug.</i> WDCM 00024		<i>B. cer.</i> WDCM 00151		<i>S. aur.</i> WDCM 00034	
	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC
	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL
<i>Origanum vulgare</i>	5	>5	2.5	5	0.625	0.625	0.625	0.625
<i>Ocimum basilicum</i>	>5	>5	5	>5	>5	>5	5	5
<i>Petroselinum crispum</i>	>5	>5	>5	>5	>5	>5	>5	>5
<i>Rosmarinus officinalis</i>	>5	>5	2.5	5	1.25	5	0.625	0.625
<i>Allium schoenoprasum</i>	>5	>5	5	>5	>5	>5	>5	>5

Oregano and rosemary extracts also inhibited the growth of the Gram-negative bacterium *Pseudomonas aeruginosa*, with MIC values of 2.5 mg/mL and minimum bactericidal concentrations (MBC) of 5 mg/mL, but exhibited very weak activity against *Escherichia coli*, with higher MIC and MBC values. Other extracts at tested concentrations showed no effect, except basil and chives extracts on *P. aeruginosa*. The antibacterial action of plants from the Lamiaceae family has been confirmed in several studies [58], [59]. Ličina et al. [60] found that the antibacterial activity of ethanol extract of *Origanum vulgare*, growing wild in

Serbia, against Gram-positive bacteria *S. aureus* ATCC 25923 and *B. cereus* (isolate) was somewhat stronger, with lower MIC values than in our study, while MIC values for Gram-negative *E. coli* 25922 and *P. aeruginosa* ATCC 27853 were two and four times higher, respectively [60].

In this study rosemary extract showed significant inhibitory effects on *S. aureus*, *B. cereus*, and *P. aeruginosa*. However, the MIC and MBC concentrations were considerably lower than those reported by Golshani and Sharifzadeh [61] and Manilal et al. [62]. Zhong et al. [57] demonstrated that different components of the polar fraction of rosemary

Savanović, D. et al. (2025). Effect of selected plant species on the antioxidant and antimicrobial properties of Janj cheese. *STED Journal*, 7(2), 8-19.

extract exhibit varying inhibitory activities against different bacterial species. In this study Gram-positive bacteria were more sensitive to the extracts than Gram-negative ones, with *P. aeruginosa* showing higher susceptibility than *E. coli*. The greater efficacy of plant species against Gram-positive bacteria has been confirmed in many studies and is generally attributed to differences in cell wall structure.

The antifungal activity of the ethanol extracts of selected plant species was weakly expressed, except for oregano and basil extracts, which exhibited a MIC of 5 mg/mL against both *Candida* species (Table 5). Ličina et al. [60] reported the same MIC value for *Candida albicans* ATCC 10231, although in their experiment the isolate showed slightly higher resistance.

Table 5. Minimal inhibitory concentration (MIC) and minimal fungicidal concentration (MFC) of ethanol extracts of selected plant species

Plant species	<i>C. albicans</i> WDCM 00054		<i>C. albicans</i> izolat	
	MIC	MFC	MIC	MFC
	mg/mL	mg/mL	mg/mL	mg/mL
<i>Origanum vulgare</i>	5	>5	5	>5
<i>Ocimum basilicum</i>	5	>5	5	>5
<i>Petroselinum crispum</i>	>5	>5	>5	>5
<i>Rosmarinus officinalis</i>	>5	>5	>5	>5
<i>Allium schoenoprasum</i>	>5	>5	>5	>5

CONCLUSIONS

The addition of selected plant species had a significant effect on the biological properties of Janj cheese, primarily through the enhancement of its antioxidant capacity. The highest antioxidant activity was observed in cheese enriched with oregano, followed by the sample with rosemary. Basil and parsley showed a moderate effect, while chives had the least impact. Increasing the concentration of plant species from 0.50% to 1.00% resulted in a proportional increase in total phenolic content and antioxidant activity, indicating a dose-dependent relationship and enabling precise control over the product's functional properties.

Although oregano and rosemary extracts exhibited pronounced antibacterial activity in independent tests, extracts obtained from the enriched Janj cheese did not demonstrate significant antimicrobial effects. This discrepancy may be attributed to the reduced concentration and bioavailability of active compounds within the complex cheese matrix, as well as possible interactions during the production process that may diminish their efficacy. These findings highlight the challenges of transferring the full antimicrobial potential of plant species into dairy products and underscore the need for

further research focused on optimizing formulations, delivery methods, or synergistic combinations to enhance bioactivity.

Incorporating selected plant species, especially oregano and rosemary, represents a promising and natural approach to improving the biological and functional qualities of Janj cheese. Moreover, this strategy aligns with the growing consumer demand for natural, clean-label, and functional foods that offer additional health benefits. The results support the potential application of aromatic herbs in traditional Janj cheese production to develop value-added products that foster innovation while preserving cultural heritage and responding to contemporary health trends.

ACKNOWLEDGEMENTS

This paper is a part of the project titled "Improvement of functional properties of an autochthonous milk product using selected plant species", co-financed by the Ministry of Scientific and Technological Development and Higher Education of Republic of Srpska.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURE

1. Official Gazette of Bosnia and Herzegovina. (2011). Regulation on milk and dairy products. No 21.
2. Walther, B., Schmid, A., Sieber, R., & Wehrmüller, K. (2008). *Cheese in nutrition and health. Dairy Science & Technology*, 88(4–5), 389–405.
<https://doi.org/10.1051/dst:2008012>
3. Jeronimo, E., & Malcata, F. X. (2016). Cheese: Composition and health effects. In *Encyclopedia of Food and Health* (pp. 741–747). <https://doi.org/10.1016/B978-0-12-384947-2.00137-9>
4. Rizzoli, R. (2022). Dairy products and bone health. *Aging Clinical and Experimental Research*, 34, 9–24.
<https://doi.org/10.1007/s40520-021-01970-4>
5. Montel, M-C., Buchin, S., Mallet, A., Delbes-Paus, C., Vuitton, D. A., Desmasures, N., & Berthier, F. (2014). Traditional cheeses: Rich and diverse microbiota with associated benefits. *International Journal of Food Microbiology*, 177, 136–154.
<https://doi.org/10.1016/j.ijfoodmicro.2014.02.019>
6. Wolfe, B. E., Button, J. E., Santarelli, M., & Dutton, R. J. (2014). Cheese rind communities provide tractable systems for in situ and in vitro studies of microbial diversity. *Cell*, 158(2), 422–433. doi: [10.1016/j.cell.2014.05.041](https://doi.org/10.1016/j.cell.2014.05.041)
7. Leroy, F., & De Vuyst, L. (2004). Lactic acid bacteria as functional starter cultures for the food fermentation industry. *Trends in Food Science & Technology*, 15(2), 67–78.
<https://doi.org/10.1016/j.tifs.2003.09.004>
8. Vujko, A., Arsić, M., & Bojović, R. (2025). From local product to destination identity: Leveraging cave-aged cheese for sustainable rural tourism development. *Agriculture*, 15(11), 1137.
<https://doi.org/10.3390/agriculture1511137>
9. Mujić, S. (2022). *Domaćice u Janju “upliču” sir – jedine ga tako prave u svijetu*. Agro Klub.
<https://www.agroklub.ba/prehrambeno-industrija/domacice-u-janju-uplicu-sir-jedine-ga-tako-prave-u-svijetu/76466/>
10. Pérez-Jiménez, J., Neveu, V., Vos, F., & Scalbert, A. (2010). Identification of the 100 richest dietary sources of polyphenols: An application of the Phenol-Explorer database. *European Journal of Clinical Nutrition*, 64(S3), S112–S120. DOI: [10.1038/ejcn.2010.221](https://doi.org/10.1038/ejcn.2010.221)
11. Burt, S. (2004). Essential oils: Their antibacterial properties and potential applications in foods—a review. *International Journal of Food Microbiology*, 94(3), 223–253.
<https://doi.org/10.1016/j.ijfoodmicro.2004.03.022>
12. Bakkali, F., Averbeck, S., Averbeck, D., & Idaomar, M. (2008). Biological effects of essential oils – A review. *Food and Chemical Toxicology*, 46(2), 446–475.
<https://doi.org/10.1016/j.fct.2007.09.106>
13. Cushnie, T. P. T., Cushnie, B., & Lamb, A. J. (2014). Alkaloids: An overview of their antibacterial, antibiotic-enhancing and antivirulence activities. *International Journal of Antimicrobial Agents*, 44(5), 377–386.
<https://doi.org/10.1016/j.ijantimicag.2014.06.001>
14. Dorman, H. J. D., & Deans, S. G. (2000). Antimicrobial agents from plants: Antibacterial activity of plant volatile oils. *Journal of Applied Microbiology*, 88(2), 308–316. <https://doi.org/10.1046/j.1365-2672.2000.00969.x>
15. Tajkarimi, M. M., Ibrahim, S. A., & Cliver, D. O. (2010). Antimicrobial herb and spice compounds in food. *Food Control*, 21(9), 1199–1218.
<https://doi.org/10.1016/j.foodcont.2010.02.003>
16. Gyawali, R., & Ibrahim, S. A. (2014). Natural products as antimicrobial agents. *Food Control*, 46, 412–429.
<https://doi.org/10.1016/j.foodcont.2014.05.047>
17. Raut, J. S., & Karuppayil, S. M. (2014). A status review on the medicinal properties of essential oils. *Industrial Crops and Products*, 62, 250–264.

- <https://doi.org/10.1016/j.indcrop.2014.05.055>
18. Josipović, R., Markov, K., Frece, J., Stanzer, D., Cvitković, A., Mrvčić, J. (2016). Upotreba začina u proizvodnji tradicionalnih sireva, *Mljekarstvo*, 66(1), 12-25.
<https://doi.org/10.15567/mljekarstvo.2016.0102>
19. Gad, A., & Sayd, A. (2015). Antioxidant properties of rosemary and its potential uses as natural antioxidant in dairy products—A review. *Food and Nutrition Sciences*, 6, 179-193. DOI: [10.4236/fns.2015.61019](https://doi.org/10.4236/fns.2015.61019)
20. Ankri, S., & Mirelman, D. (1999). Antimicrobial properties of allicin from garlic. *Microbes and Infection*, 1(2), 125-129. [https://doi.org/10.1016/S1286-4579\(99\)80003-3](https://doi.org/10.1016/S1286-4579(99)80003-3)
21. Pham-Huy, L. A., He, H., & Pham-Huy, C. (2008). Free radicals, antioxidants in disease and health. *International Journal of Biomedical Science*, 4(2), 89-96. PMID: [PMC3614697](https://pubmed.ncbi.nlm.nih.gov/PMC3614697/)
22. Nieto, G., Ros, G., & Castillo, J. (2018). Antioxidant and Antimicrobial Properties of Rosemary (*Rosmarinus officinalis*, L.): A Review. *Medicines*, 5(3), 98. <https://doi.org/10.3390/medicines5030098>
23. Gülçin, İ. (2012). Antioxidant activity of food constituents: An overview. *Archives of Toxicology*, 86(3), 345–391. <https://doi.org/10.1007/s00204-011-0774-2>
24. Ultee, A., Kets, E. P. W., & Smid, E. J. (1999). Mechanisms of Action of Carvacrol on the Food-Borne Pathogen *Bacillus cereus*. *Applied and Environmental Microbiology*, 65(10), 4606-4610. <https://doi.org/10.1128/AEM.65.10.4606-4610.1999>
25. Nazzaro, F., Fratianni, F., De Martino, L., Coppola, R., & De Feo, V. (2013). Effect of essential oils on pathogenic bacteria. *Pharmaceuticals*, 6(12), 1451-1474. <https://doi.org/10.3390/ph6121451>
26. Muntean, D., & Vulpie, S. (2023). Antioxidant and antibacterial activity of plant extracts. *Antibiotics*, 12(7), 1176. <https://doi.org/10.3390/antibiotics12071176>
27. Wolfe, K., Wu, X., & Liu, R. H. (2003). Antioxidant Activity of Apple Peels. *Journal of Agricultural and Food Chemistry*, 51(3), 609–614. <https://doi.org/10.1021/jf020782a>
28. Alberto, M. R., Rinsdahl Canavosio, M. A., & Manca de Nadra, M. C. (2006). Antimicrobial effect of polyphenols from apple skins on human bacterial pathogens. *Electronic Journal of Biotechnology*, 9(3). DOI: 10.2225/vol9-issue3-fulltext-1
29. Liyana-Pathirana, C. M., & Shahidi, F. (2005). Antioxidant Activity of Commercial Soft and Hard Wheat (*Triticum aestivum* L.) as Affected by Gastric pH Conditions. *Journal of Agricultural and Food Chemistry*, 53(7), 2433–2440. <https://doi.org/10.1021/jf049320i>
30. Re, R., Pellegrini, N., Proteggente, A., Pannala, A., Yang, M., & Rice-Evans, C. (1999). Antioxidant activity applying an improved ABTS radical cation decolorization assay. *Free Radical Biology & Medicine*, 26(9–10), 1231-1237. [https://doi.org/10.1016/S0891-5849\(98\)00315-3](https://doi.org/10.1016/S0891-5849(98)00315-3)
31. Benzie, I. F. F., & Strain, J. J. (1996). The Ferric Reducing Ability of Plasma (FRAP) as a Measure of “Antioxidant Power”: The FRAP Assay. *Analytical Biochemistry*, 239(1), 70–76. <https://doi.org/10.1006/abio.1996.0292>
32. European Committee for Antimicrobial Susceptibility Testing (EUCAST) of the European Society of Clinical Microbiology and Infectious Diseases (ESCMID). (n.d.). Determination of minimum inhibitory concentrations (MICs) of antibacterial agents by agar dilution. *Clinical Microbiology and Infection*, 6(9), 509-515.
33. Wiegand, I., Hilpert, K., & Hancock, R. E. W. (2008). Agar and broth dilution method to determine the minimal inhibitory concentration (MIC) of antimicrobial substances. *Nature Protocols*, 3(2), 163-175. <https://doi.org/10.1038/nprot.2007.521>
34. Balouiri, M., Sadiki, M., & Ibensouda, S. K. (2016). Methods for in vitro evaluating antimicrobial activity: A review. *Journal*

- of *Pharmaceutical Analysis*, 6, 71-79.
<https://doi.org/10.1016/j.jpha.2015.11.005>
35. Josipović, R., Knežević Medverec, Z., Frece, J., Markov, K., Kazaić, S., & Mrvčić, J. (2015). Improved properties and microbiological safety of novel cottage cheese containing spices. *Food Technology and Biotechnology*, 53(4), 454-462. DOI: [10.17113/ftb.53.04.15.4029](https://doi.org/10.17113/ftb.53.04.15.4029)
 36. Zhang, X. L., Guo, Y. S., Wang, C. H., Li, G. Q., Xu, J. J., Chung, H. Y., Ye, W. C., Li, Y. L., & Wang, G. C. (2014). Phenolic compounds from *Origanum vulgare* and their antioxidant and antiviral activities. *Food Chemistry*, 152, 300-306. <https://doi.org/10.1016/j.foodchem.2013.11.153>
 37. Todorović, V., Dančetočić, A., Dabetić, N., Šobajić, S., & Vidović, B. (2018). Antioksidativna aktivnost odabranih začina sa tržišta Srbije. *Hrana i Ishrana*, 59(2), 74-79. DOI: [10.5937/HraIsh1802074T](https://doi.org/10.5937/HraIsh1802074T)
 38. Simirgiotis, M. J., Burton, D., Parra, F., López, J., Muñoz, P., Escobar, H., & Parra, C. (2020). Antioxidant and antibacterial capacities of *Origanum vulgare* L. essential oil from the arid Andean region of Chile and its chemical characterization by GC-MS. *Metabolites*, 10(10), 414. <https://doi.org/10.3390/metabo10100414>
 39. Khorsand, G. J., Morshedloo, M. R., Mumivand, H. et al. (2022). Natural diversity in phenolic components and antioxidant properties of oregano (*Origanum vulgare* L.) accessions, grown under the same conditions. *Scientific Reports*, 12, 5813. <https://doi.org/10.1038/s41598-022-09742-4>
 40. Petersen, M., & Simmonds, M. S. J. (2003). Rosmarinic acid. *Phytochemistry*, 62(2), 121-125. [https://doi.org/10.1016/S0031-9422\(02\)00513-7](https://doi.org/10.1016/S0031-9422(02)00513-7)
 41. Guo, M., Yang, L., Li, X., Tang, H., Li, X., Xue, Y., & Duan, Z. (2023). Antioxidant efficacy of rosemary extract in improving the oxidative stability of rapeseed oil during storage. *Foods*, 12(19), 3583. <https://doi.org/10.3390/foods12193583>
 42. Clarke, H. J., McCarthy, W. P., O'Sullivan, M. G., Kerry, J. P., & Kilcawley, K. N. (2021). Oxidative Quality of Dairy Powders: Influencing Factors and Analysis. *Foods (Basel, Switzerland)*, 10(10), 2315. <https://doi.org/10.3390/foods10102315>
 43. El-Sayed, M. M., Metwally, N. H., Ibrahim, I. A., Abdel-Hady, H., & Abdel-Wahab, B. S. A. (2018). Antioxidant activity, total phenolic and flavonoid contents of *Petroselinum crispum* Mill. *Journal of Applied Life Sciences International*, 19(2), 1-7. DOI: [10.9734/JALSI/2018/45113](https://doi.org/10.9734/JALSI/2018/45113)
 44. Qamar, F., Sana, A., Naveed, S., & Faizi, S. (2023). Phytochemical characterization, antioxidant activity and antihypertensive evaluation of *Ocimum basilicum* L. in l-NAME induced hypertensive rats and its correlation analysis. *Heliyon*, 9(4), e14644. DOI: [10.1016/j.heliyon.2023.e14644](https://doi.org/10.1016/j.heliyon.2023.e14644)
 45. Rice-Evans, C. A., Miller, N. J., & Paganga, G. (1996). Structure-antioxidant activity relationships of flavonoids and phenolic acids. *Free Radical Biology and Medicine*, 20(7), 933-956. [https://doi.org/10.1016/0891-5849\(95\)02227-9](https://doi.org/10.1016/0891-5849(95)02227-9)
 46. Heim, K.E., Tagliaferro, A.R., & Bobilya, D.J. (2002). Flavonoid antioxidants: Chemistry, metabolism and structure-activity relationships. *The Journal of Nutritional Biochemistry*, 13(10), 572-584. [https://doi.org/10.1016/S0955-2863\(02\)00208-5](https://doi.org/10.1016/S0955-2863(02)00208-5)
 47. Pihlanto, A. (2006). Antioxidative peptides derived from milk proteins. *International Dairy Journal*, 16(11), 1306-1314. <https://doi.org/10.1016/j.idairyj.2006.06.005>
 48. Stanojević, L. P., Stanojević, J. S., Cvetković, D. J., & Ilić, D. P. (2016). Antioxidant activity of oregano essential oil (*Origanum vulgare* L.). *Biologica Nyssana*, 7(2), 131-139. DOI: 10.5281/zenodo.200410
 49. Han, F., Ma, G. Q., Yang, M., Yan, L., Xiong, W., Shu, J. C., Zhao, Z. D., & Xu, H. L. (2017). Chemical composition and antioxidant activities of essential oils from different parts of the oregano. *Journal of*

Savanović, D. et al. (2025). Effect of selected plant species on the antioxidant and antimicrobial properties of Janj cheese. *STED Journal*, 7(2), 8-19.

- Zhejiang University Science B*, 18(1), 79–84. <https://doi.org/10.1631/jzus.B1600377>
50. Dragan, F., Moisa, C. F., Teodorescu, A., Burlou-Nagy, C., Fodor, K. I., Marcu, F., Popa, D. E., & Teaha, D. I. M. (2022). Evaluating in vitro antibacterial and antioxidant properties of *Origanum vulgare* volatile oil. *Farmacia*, 70(6), 1114-1122. <https://doi.org/10.31925/farmacia.2022.6.15>
51. Stan, M., Soran, M. L., Varodi, C., & Lung, I. (2012). Extraction and identification of flavonoids from parsley extracts by HPLC analysis. *AIP Conference Proceedings*, 1425(1), 50–52. <https://doi.org/10.1063/1.3681964>
52. Ghasemzadeh, A., Ashkani, S., Baghdadi, A., Pazoki, A., Jaafar, H. Z., & Rahmat, A. (2016). Improvement in flavonoids and phenolic acids production and pharmaceutical quality of sweet basil (*Ocimum basilicum* L.) by ultraviolet-B irradiation. *Molecules*, 21(9), 1203. <https://doi.org/10.3390/molecules21091203>
53. Lenková, M., Bystrická, J., Tóth T., Hrstková, M. (2016). Evaluation and comparison of the content of total polyphenols and antioxidant activity of selected species of the genus *Allium*. *Journal of Central European Agriculture*, 17(4), 1119-1133. <https://doi.org/10.5513/JCEA01/17.4.1820>
54. Vuković, S., Popović-Đorđević, J. B., Kostić, A. Ž., Pantelić, N. D., Srećković, N., Akram, M., Laila, U., & Katanić Stanković, J. S. (2023). *Allium* species in the Balkan region—Major metabolites, antioxidant and antimicrobial properties. *Horticulturae*, 9(3), 408. <https://doi.org/10.3390/horticulturae9030408>
55. Prior, R. L., Wu, X., & Schaich, K. (2005). Standardized methods for the determination of antioxidant capacity and phenolics in foods and dietary supplements. *Journal of Agricultural and Food Chemistry*, 53(10), 4290–4302. DOI: [10.1021/jf0502698](https://doi.org/10.1021/jf0502698)
56. Djeridane, A., Yousfi, M., Nadjemi, B., Boutassouna, D., Stocker, P., & Vidal, N. (2006). Antioxidant activity of some Algerian medicinal plants extracts containing phenolic compounds. *Food Chemistry*, 97(4), 654–660. <https://doi.org/10.1016/j.foodchem.2005.04.028>
57. Zhong, X., Wang, X., Zhou, N., Li, J., Liu, J., Yue, J., Hao, X., Gan, M., Lin, P., & Shang, X. (2021). Chemical characterization of the polar antibacterial fraction of the ethanol extract from *Rosmarinus officinalis*. *Food Chemistry*, 344, 128674. <https://doi.org/10.1016/j.foodchem.2020.128674>
58. Btissam, R., Fatima, E. M., Kamal, E., Hassane G., & Mohamed, N. (2018). Composition and antibacterial activity of hydro-alcohol and aqueous extracts obtained from the Lamiaceae family. *Pharmacognosy Journal*, 10(1), 81-91. DOI: [10.5530/pj.2018.1.16](https://doi.org/10.5530/pj.2018.1.16)
59. György, E., Laslo, E., & Salamon, B. (2023). Antimicrobial impacts of selected Lamiaceae plants on bacteria isolated from vegetables and their application in edible films. *Food Bioscience*, 51. <https://doi.org/10.1016/j.fbio.2022.102280>
60. Ličina, B. L., Stefanović, O. D., Vasić, S. M., Radojević, I. D., Dekić, M. S., & Čomić, L. J. R. (2013). Biological activities of the extracts from wild growing *Origanum vulgare* L. *Food Control*, 33(2), 498-504. <https://doi.org/10.1016/j.foodcont.2013.03.020>
61. Golshani, Z., & Sharifzadeh, A. (2014). Evaluation of antibacterial activity of alcoholic extract of rosemary leaves against pathogenic strains. *Zahedan Journal of Research in Medical Sciences*, 16(3), 12-15.
62. Manilal, A., Sabu, K. R., Woldemariam, M., Aklilu, A., Biresaw, G., Yohanes, T., Seid, M., & Merdekios, B. (2021). Antibacterial activity of *Rosmarinus officinalis* against multidrug-resistant clinical isolates and meat-borne pathogens. *Evidence-Based Complementary and Alternative Medicine*, Article 6677420. <https://doi.org/10.1155/2021/6677420>

IMPACT OF FLAXSEED CAKE HYDROLYSIS ON ANTIOXIDANT CAPACITY

Tanja Krunić

University of Belgrade, Innovation center of the Faculty of Technology and Metallurgy in Belgrade Ltd., Karnegijeva 4, 11000 Belgrade, Serbia, tkrunic@tmf.bg.ac.rs

ORIGINAL SCIENTIFIC PAPER

ISSN 2637-2150

e-ISSN 2637-2614

DOI 10.63395/STEDJournal0702085K20

UDC 633.521:547.458.88

COBISS.RS-ID 143559425

Received: 11 September 2025.

Revised: 06 November 2025.

Accepted: 12 November 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Corresponding Author: Tanja Krunić, University of Belgrade, Innovation center of the Faculty of Technology and Metallurgy in Belgrade Ltd., Karnegijeva 4, 11000 Belgrade, Serbia, tkrunic@tmf.bg.ac.rs



Copyright © 2024 Tanja Krunić; published by UNIVERSITY PIM. This work licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.

Citation: Krunić, T. (2025). Impact of flaxseed cake hydrolysis on antioxidant capacity. *STED Journal*, 7(2), 20-27. <https://doi.org/10.63395/STEDJournal0702085K20>

ABSTRACT

Cold pressing of flaxseed produces high-quality oil along with a nutritionally rich by-product—flaxseed cake. While the cold-pressing process is valued for its minimal processing and preservation of oil quality, it is also characterized by low resource utilization efficiency and significant by-product generation. Specifically, the production of 1 kg of flaxseed oil results in approximately 2

kg of residual cake. Given its high protein content (approximately 30–40%), flaxseed cake holds considerable potential as a source of bioactive peptides and other value-added compounds

In this study, flaxseed cake obtained from cold pressing was milled and sieved to a particle size below 0.6 mm. Its chemical composition (protein, oil, fiber) was analyzed. Controlled enzymatic hydrolysis was performed with trypsin for 2 h. An E/S ratio was 5 %, and the temperature used for hydrolysis was 37 °C. The antioxidant capacity of the non-hydrolyzed sample and hydrolysate was determined.

Protein content was 37 %, oil was about 21 %, and fiber was approximately 28 %. The results showed a degree of hydrolysis of about 5 % and a significant increase in antioxidant activity. By determining the concentration of flaxseed powder required to inhibit 50 % of the DPPH free radicals, it was observed that this concentration was significantly ($p < 0.05$) higher in the non-hydrolyzed sample (11.0 mg/mL) compared to the hydrolysate (9.1 mg/mL).

Keywords: hydrolysis, protein, trypsin, bioactivity.

INTRODUCTION

Flaxseed (*Linum usitatissimum* L.) has gained increasing attention in both the food and nutraceutical industries due to its rich nutritional composition and health-promoting properties, including high levels of α -linolenic acid, lignans, and dietary fiber [1]. Cold pressing is a widely used method for extracting flaxseed oil, favoured for its ability to preserve bioactive compounds through minimal thermal degradation [2]. However, this process results in significant amounts of by-product named flaxseed cake.

Despite being commonly used as animal feed, flaxseed cake is rich in valuable nutrients, particularly proteins (>35), residual oil (up to 20%), and dietary fiber with carbohydrate (up to 40%) [3]. These attributes position it as a promising raw material for extracting bioactive compounds, particularly peptides with antioxidant potential. Enzymatic hydrolysis has proven to be an effective strategy for releasing such peptides from proteins [4], [5]. Through controlled proteolytic action, enzymatic treatment can enhance the functional and biological properties of proteins by generating low-molecular-weight peptides with higher bioavailability and antioxidant capacity [4], [6].

In addition to enzymatic hydrolysis, microbial hydrolysis is another method used to break down proteins into bioactive peptides and amino acids. Microbial hydrolysis relies on the natural proteolytic activity of live microorganisms, such as *Lactobacillus* species [7], which are commonly used in traditional food fermentations like yogurt, miso, and tempeh [8]. These microbes secrete a variety of enzymes that degrade proteins during fermentation.

While microbial hydrolysis has benefits, such as lower cost, natural processing, and additional nutritional enrichment (e.g., vitamins, probiotics), it also presents several limitations. The most common limitations are:

- The less controlled process, as microorganisms can produce a mixture of enzymes and metabolites, resulting in variability in peptide profiles.
- The slower process often requires several hours or days.
- The higher risk of contamination, especially in non-sterile environments.
- The process is hard to standardize- the bioactivity and composition of the final product are more difficult to standardize [9], [5].

In contrast, enzymatic hydrolysis uses purified, well-characterized enzymes under strictly controlled conditions. This allows for:

- Precise and reproducible hydrolysis,
- Faster reaction times, typically within 3 hours,

- Improved safety, due to the absence of live microbes,
- Targeted generation of specific bioactive peptides, which is crucial for maximizing health benefits such as antioxidant, antihypertensive, or immunomodulatory effects [10], [5], [4].

Although microbial hydrolysis remains valuable in traditional food systems, enzymatic hydrolysis is generally preferred in industrial and functional food applications due to its higher efficiency, reproducibility, and safety.

This study investigates the valorisation of cold-pressed by-product via enzymatic hydrolysis using trypsin. The focus is on characterizing its chemical composition and evaluating the antioxidant potential of the resulting protein hydrolysate. The work aims to contribute to the development of sustainable strategies for the utilization of flaxseed by-products in functional food and nutraceutical applications.

METHODS AND MATERIALS

Materials

In this work, flaxseed cake was obtained from Linum d.o.o.. Commercially available protease used in this work was trypsin (EC 3.4.21.4, Sigma-Aldrich Chemie GmbH, USA). DPPH and other analytical grade reagents were also purchased from Sigma-Aldrich Chemie GmbH, USA.

Flaxseed cake pre-treatment

Flaxseed cake, obtained from the cold-pressed oils industry, was used. The composition of the raw material was determined before hydrolysis. Flaxseed cake was ground in a ball mill and sieved through a sieve with a pore size of 0.6 mm. The flaxseed powder obtained in this way was sterilized in an autoclave at 120 °C, with a pressure of 1.5 bar for 30 minutes. After sterilization, the flaxseed powder was diluted in distilled water to a 5% (w/v) concentration.

Flaxseed cake composition

Moisture and dry matter content

The moisture/dry matter content in the flaxseed powders was determined by the

Krunić, T. (2025). Impact of flaxseed cake hydrolysis on antioxidant capacity. *STED Journal*, 7(2), 20-27.

KERN moisture analyzer DBS 60-3 (Mechanikus Gottlieb KERN, Germany).

used (Behr-Labor Technik GmbH, Germany, Figure 2).

Oil content

To determine the oil content in flaxseed cake, the Soxhlet extraction method was used, employing a semi-automatic Behr ES 2+2 apparatus (Behr-Labor Technik GmbH, Germany, Figure 1).

Determination of fiber content

To determine the fiber content in flaxseed cake, the Behr EN 4V WBM was

Determination of protein content

To determine protein content in flaxseed cake, the Kjeldahl method was used. The equipment for this analysis was a Kjeldahl infrared rapid digestion unit from Behr-Labor Technik GmbH, Germany (Figure 3).

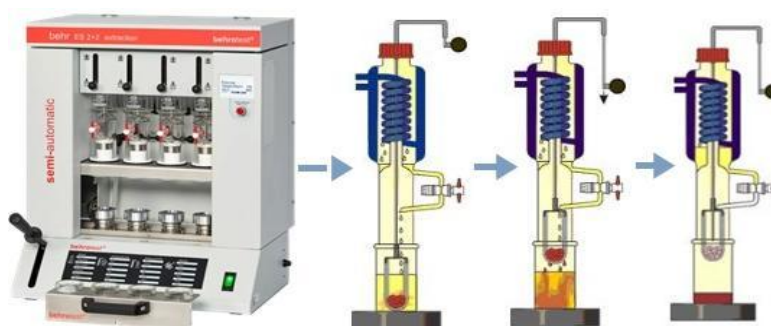


Figure 1. Determination of oil amount in flaxseed cake



Figure 2. Apparatus for the determination of fibre content



Figure 3. Apparatus for determining protein amount by the Kjeldahl method in flaxseed cake

Controlled enzymatic hydrolysis

Flaxseed powder was reconstructed in distilled water to a concentration of 5.0 % (w/v). The mixture was allowed to hydrate for 1 h at room temperature while gently stirring. Hydrolysis was performed as described by Krunić and Rakin (2025) using trypsin (EC 3.4.21.4) under optimal conditions: pH 8.0 / 37 °C. The enzyme/substrate ratio was 5.0% (w/w). During the reaction, pH was kept at a

constant value by adding 1M NaOH, using the pH-stat method with automatic dosage of the base. The reaction was stopped after 2 h by heating the mixture at 100°C for 10 min to inactivate the enzyme. The hydrolysate obtained was cooled down to room temperature for future analysis. The degree of hydrolysis (DH) was determined using the pH stat method described by Alder-Nissen (1986). It was calculated by the following equation.

$$DH \text{ (\%)} = B \times Nb \times (1/\alpha) \times (1/mp) \times (1/htot) \times 100 \quad (1)$$

Where B is the consumption of the base in mL, Nb is the normality of the base, mp is the mass of protein in g, htot is the total amount of peptide bonds per weight unit of a protein and can be calculated from its amino acid composition (for flaxseed htot is 7.8 mmol/g protein [11]), α is the degree of dissociation of the α -amino groups ($1/\alpha=1.26$ at 37 °C and pH 8.0 (Adler-Nissen, 1986)).

Determination of the inhibition of DPPH free radicals

The flaxseed powder, un-hydrolysed and hydrolysed, was taken in two different dilutions (0.5 and 1%) and mixed with 0.1 mM–thanol DPPH free radical, in a ratio 1 : 18. Mixtures were homogenized and left in the dark for 30 min. The absorbance was measured at 517 nm using a UV-visible spectrophotometer (Ultrospec 3300 pro, Amerischam Bioscienc). For making control, ethanol was used instead of the sample. The antioxidant activity was expressed as a percentage of DPPH activity calculated as:

$$DPPH \text{ capacity (\%)} = \frac{\text{Absorbance of blank} - \text{Absorbance of sample}}{\text{Absorbance of blank}} \times 100 \quad (2)$$

The concentration of flaxseed powder required to inhibit 5% of the DPPH free radicals (IC₅₀) was calculated.

Statistical analysis

All experiments were performed in triplicate, and the results are presented as means with standard deviations. The Tukey test was used to determine significant differences between samples ($p < 0.05$). Data analysis was conducted using Microsoft Excel (Microsoft Office 2013 Edition, USA) and OriginPro 8 (Origin Lab Co., Northampton, USA).

RESULTS AND DISCUSSION

This study investigates the potential use of flaxseed cake, a by-product generated in large quantities during the production of cold-pressed flaxseed oil, as a component of functional food. As can be seen in Table 1, the protein component is $37.1 \pm 2.5\%$ which makes flaxseed cake a good raw material for controlled enzymatic hydrolysis to obtain bioactive peptides.

Many food proteins contain biologically active peptides that can be released through gastrointestinal digestion or controlled enzymatic hydrolysis. Research has demonstrated that controlled enzymatic hydrolysis of food protein can enhance the functional and nutritional properties, as well as

Krunić, T. (2025). Impact of flaxseed cake hydrolysis on antioxidant capacity. *STED Journal*, 7(2), 20-27.

biological activities of food [5], [4], [6]. Hydrolysis of food protein with digestive enzymes (such as trypsin, chymotrypsin, and pepsin) is a very common practice, and many

results are achieved. In this study, the digestive enzyme trypsin was used, and the degree of hydrolysis obtained after 2h is shown in Figure 4.

Table 1. Flaxseed cake composition

	Protein, %	Oil, %	Fiber, %	Moister, %
Flaxseed cake	37.1 ± 2.5	20.7 ± 1.2	28.0 ± 3.5	8.1 ± 0.9

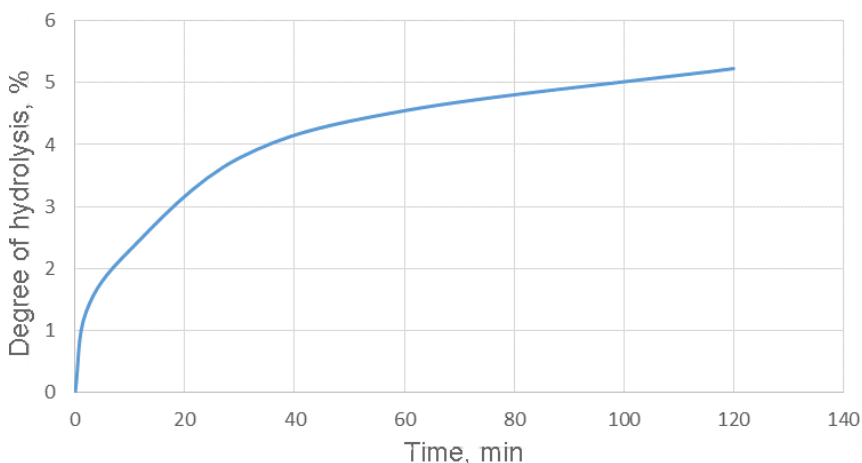


Figure 4. The degree of hydrolysis after 120 min of trypsin hydrolysis of flaxseed powder (Enzyme/Protein ratio is 5:100)

A degree of hydrolysis of 5% is significantly lower compared to the degree of hydrolysis obtained under identical conditions, but in half the time for whey protein, where the hydrolysis was twice as high [12], [4], [6]. This is consistent with literature reports that describe the resistance of cereal proteins to trypsin. Research has confirmed that cereal proteins, such as those from wheat and barley, contain α -amylase/trypsin inhibitors that are resistant to enzymatic digestion. These inhibitors form part of a multigene family and are structurally adapted to resist degradation by trypsin, contributing to the inherent resistance of cereal proteins to proteolysis [13]. Flaxseed contains trypsin inhibitors and compounds that inhibit α -amylase, but these are likely separate mechanisms rather than a classical bifunctional inhibitor protein commonly found in cereal grains [14], [15].

Flaxseed contains measurable levels of trypsin inhibitor activity. Laboratory-prepared flaxseed meal samples showed trypsin inhibitor levels ranging from 42–51 units, while commercial samples had 14–37 units, which is significantly lower than soybean meal (1650 units), but still present and relevant [14].

Flaxseed possesses a high antioxidant capacity, primarily attributed to its lignan content, which is up to 30 times higher than that of any other plant. The antioxidant potential of flaxseed can be further enhanced through microbial or enzymatic protein hydrolysis. Figure 5 presents the antioxidant capacity of flaxseed powder before and after hydrolysis at concentrations of 0.5 % and 1 %. A significant increase in antioxidant capacity is evident following controlled hydrolysis using trypsin. By determining the

concentration of flaxseed powder required to inhibit 50 % of the DPPH free radicals (IC_{50}), it was observed that this concentration was significantly higher in the non-hydrolyzed

sample (11.0 mg/mL) compared to the hydrolyzed one (9.1 mg/mL). This is in accordance with the literature [16], [17].

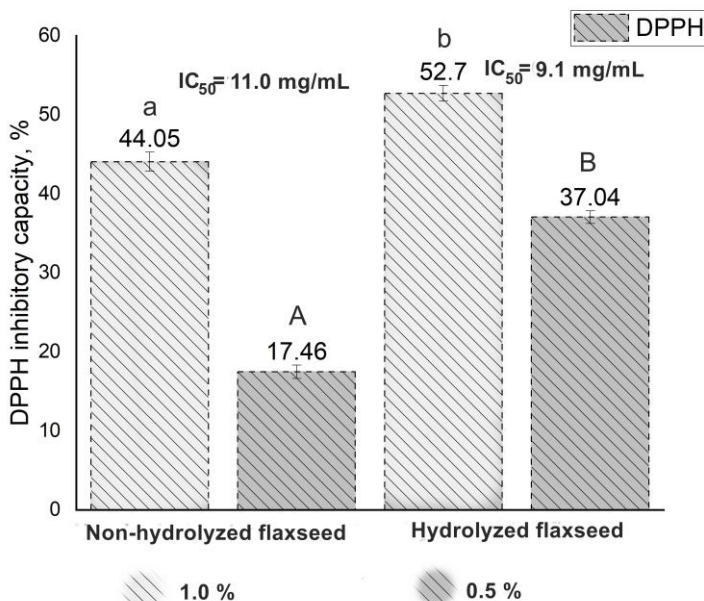


Figure 5. Antioxidant capacity of flaxseed powder water after 120 min of hydrolysis by trypsin with an Enzyme/Protein ratio 5:100 (flaxseed powder was diluted to 1 and 0.5 % in distilled water). Values followed by different letters are significantly different from each other ($p < 0.05$)

Trypsin hydrolysis significantly increased the antioxidant capacity of flaxseed protein compared to its native form. This included improvements in DPPH radical scavenging, reducing power, and metal ion chelating activity [16]. Hydrolysates from trypsin-treated flaxseed protein exhibit improved antioxidant effects due to the release of bioactive peptides with lower molecular weight, which are more effective in scavenging radicals and chelating metals [18]. Also, pre-treating flaxseed protein with high hydrostatic pressure before trypsin hydrolysis resulted in peptides with significantly higher antioxidant activity, suggesting pressure can enhance enzyme accessibility and peptide bioactivity [19], [17]. The antioxidant capacity of the obtained peptides depends more on the type of enzyme used than on the duration of hydrolysis, since enzymes have specific

binding and cleavage sites on proteins, which determine the bioactivity of the resulting peptides [5], [4].

CONCLUSION

This study investigates the potential use of flaxseed cake, a by-product generated in large quantities during the production of cold-pressed flaxseed oil, as a component of functional food. The protein component of $37.1 \pm 2.5\%$ makes flaxseed cake a good raw material for controlled enzymatic hydrolysis to obtain bioactive peptides. This study demonstrates that controlled enzymatic hydrolysis using trypsin can enhance the antioxidant capacity of flaxseed powder by releasing bioactive peptides. Although flaxseed proteins exhibit partial resistance to enzymatic digestion, likely due to the presence of trypsin inhibitors, the hydrolysis achieved

was sufficient to significantly improve functional properties. The antioxidant activity, as measured by DPPH radical scavenging capacity, increased notably after hydrolysis, with the IC₅₀ value of the hydrolyzed sample being significantly lower (9.1 mg/mL) compared to the non-hydrolyzed one (11.0 mg/mL). These findings highlight the potential of enzymatic treatment to improve the bioactivity of flaxseed-derived ingredients, despite inherent inhibitory factors.

Overall, hydrolyzed milled flaxseed cake can be incorporated into functional food formulations such as protein bars, yogurts, or bakery products, where it enhances nutritional value, improves fiber content, and provides bioactive compounds beneficial for gut health.

ACKNOWLEDGEMENTS

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract No. 451-03-136/2025-03/200287) and UNDP in Serbia through the Circular voucher (Contract No. 00131890/1138320/2024/01-03). Sincere thanks to Linum d.o.o. for their trust and for providing the raw materials used in this work.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURE

1. Goyal, A., Sharma, V., Upadhyay, N., Gill, S., & Sihag, M. (2014). Flax and flaxseed oil: an ancient medicine & modern functional food. *Journal of Food Science and Technology*, 51(9), 1633–1653. <https://doi.org/10.1016/j.jff.2013.08.004>
2. Corzo-Martínez, M., Corzo, N., & Villamiel, M. (2012). Biological properties of onions and garlic. *Trends in Food Science & Technology*, 22(6), 321–336. <https://doi.org/10.1016/j.foodchem.2011.11.083>
3. Mazaheri, S., Ghafoori, S., & Khaksar, R. (2019). Flaxseed cake: A valuable co-product for food applications. *LWT - Food Science and Technology*, 101, 232–240. <https://doi.org/10.1016/j.lwt.2019.108488>
4. Krunić, T.Z., & Rakin, M.B. (2025). Combination of controlled enzymatic hydrolysis and ultrafiltration as the technique for bioactive peptide production intended for the food industry, *Innovative Food Science & Emerging Technologies*, 102, 103979. <https://doi.org/10.1016/j.ifset.2025.103979>
5. Krunić, T., Rakin, M., Bulatović, M., & Zarić, D. (2018). The contribution of bioactive peptides of whey to quality of food products. In A. M. Grumezescu and A. M. Holban (Eds.) *Food Processing for Increased Quality and Consumption*, (pp. 251-285). Elsevier Inc. <https://doi.org/10.1016/B978-0-12-811447-6.00009-6>
6. Krunić, T., & Rakin, M. (2025) Functional Food Ingredients: Comparative Analyses of Modifying Technological Properties of Whey Protein by Controlled Hydrolysis Using Three Types of Enzymes Trypsin, Proteinase K, and Thermolysin. James C. Taylor (Ed) *Advances in Chemistry Research*, (pp. 249-268). Nova Science Publishers New York. <https://doi.org/10.52305/TTMA3608>
7. Embiriekah, S.M., Bulatović, M.L., Gnjatović, M.L., Vukašinović-Sekulić, M.S., Krunić, T.Ž., Zarić, D.B., & Rakin, M.B. (2018). Comparative analysis of functionality of spray dried whey protein hydrolysates obtained by enzymatic and microbial hydrolysis. *Chemical Industry*, 72(5), 265-274. <https://doi.org/10.2298/HEMIND171121019E>
8. Korhonen, H., & Pihlanto, A. (2006). Bioactive peptides: Production and functionality. *Current Opinion in Biotechnology*, 17(2), 163–169. <https://doi.org/10.1016/j.copbio.2006.05.010>
9. Pownall, T. L., Udenigwe, C. C., & Aluko, R. E. (2010). Amino acid composition and antioxidant properties of pea seed (*Pisum sativum* L.) enzymatic protein hydrolysate fractions. *Food Chemistry*, 120(1), 144–150.

Krunić, T. (2025). Impact of flaxseed cake hydrolysis on antioxidant capacity. *STED Journal*, 7(2), 20-27.

<https://doi.org/10.1016/j.foodchem.2010.03.083>

10. Sarmadi, B. H., & Ismail, A. (2010). Antioxidative peptides from food proteins, *Food Chemistry*, 83(4), 587–593.
<https://doi.org/10.1016/j.foodchem.2009.07.042>
11. Adler-Nissen, J. (1986). *Enzymic hydrolysis of food proteins*. New York, USA: Elsevier Applied Science Publishers.
12. Krunić, T.Z., Obradović, N.S., & Rakin, M.B. (2019). Application of whey protein and whey protein hydrolysate as protein based carrier for probiotic starter culture. *Food Chemistry*, 293, 74-82.
13. Carbonero, P., Díaz, I., Vicente-Carbajosa, J., Alfonso-Rubí, J., Gaddour, K., & Lara, P. (1999). Cereal α -amylase/trypsin inhibitors and transgenic insect resistance. In *Genetics and Breeding for Crop Quality and Resistance: Proceedings of the XV EUCARPIA Congress, Viterbo, Italy, September 20–25, 1998* (pp. 147-158). Dordrecht: Springer Netherlands.
https://doi.org/10.1007/978-94-011-4475-9_17.
14. Bhatta, R. (1993). Further compositional analyses of flax: Mucilage, trypsin inhibitors and hydrocyanic acid. *Journal of the American Oil Chemists' Society*, 70, 899-904.
<https://doi.org/10.1007/BF02545351>.
15. Hano, C., Renouard, S., Molinié, R., Corbin, C., Barakzoy, E., Doussot, J., Lamblin, F., & Lainé, É. (2013). Flaxseed (*Linum usitatissimum* L.) extract as well as (+)-secoisolariciresinol diglucoside and its mammalian derivatives are potent inhibitors of α -amylase activity. *Bioorganic & medicinal chemistry letters*, 23(10), 3007-3012.
<https://doi.org/10.1016/j.bmcl.2013.03.029>
16. Chang, Y., Bi, C., Wang, L., Li, D., Adhikari, B., & Chen, X. (2017). Effect of Trypsin on Antioxidant Activity and Gel-Rheology of Flaxseed Protein. *International Journal of Food Engineering*, 13(3), 20160168.
<https://doi.org/10.1515/ijfe-2016-0168>
17. Franck, M., Perreault, V., Suwal, S., Marciniak, A., Bazinet, L., & Doyen, A. (2019). High hydrostatic pressure-assisted enzymatic hydrolysis improved protein digestion of flaxseed protein isolate and generation of peptides with antioxidant activity. *Food research international*, 115, 467-473.
<https://doi.org/10.1016/j.foodres.2018.10.034>.
18. Mohamed, A. (2013). *Antioxidant activity of flaxseed proteins and their hydrolysates*. M.Sc. thesis. McGill University, Montreal, Canada.
19. Perreault, V., Doyen, A., Bazinet, L., & Hénaux, L. (2017). Pretreatment of flaxseed protein isolate by high hydrostatic pressure: Impacts on protein structure, enzymatic hydrolysis and final hydrolysate antioxidant capacities. *Food Chemistry*, 221, 1805-1812.
<https://doi.org/10.1016/j.foodchem.2016.10.100>.

Velemir, A. et al. (2025). Antioxidant and antimicrobial potential of blackthorn and red cherry extracts in natural sausage casings. *STED Journal*, 7(2), 28-41.

ANTIOXIDANT AND ANTIMICROBIAL POTENTIAL OF BLACKTHORN AND RED CHERRY EXTRACTS IN NATURAL SAUSAGE CASINGS

Ana Velemir, Snježana Mandić, Aleksandar Savić, Ljiljana Topalić-Trivunović, Danica Savanović

University of Banja Luka, Faculty of Technology, Bulevar vojvode Stepe Stepanovića 73, 78000 Banja Luka, Republic of Srpska, Bosnia and Herzegovina, ana.velemir@tf.unibl.org

ORIGINAL SCIENTIFIC PAPER

ISSN 2637-2150
e-ISSN 2637-2614
DOI 10.63395/STEDJournal0702083V28
UDC 637.523.035:547.458.88
COBISS.RS-ID 143559937

Received: 19 August 2025.
Revised: 07 November 2025.
Accepted: 18 November 2025.
Published: 28 November 2025.
<https://stedjournal.com/>

Corresponding Author: Ana Velemir, University of Banja Luka, Faculty of Technology, Bulevar vojvode Stepe Stepanovića 73, 78000 Banja Luka, Bosnia and Herzegovina, ana.velemir@tf.unibl.org



Copyright © 2024 Ana Velemir, et al.; published by UNIVERSITY PIM. This work licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.

Citation: Velemir, A. et al. (2025). Antioxidant and antimicrobial potential of blackthorn and red cherry extracts in natural sausage casings. *STED Journal*, 7(2), 28-41. <https://doi.org/10.63395/STEDJournal0702083V28>

ABSTRACT

This study explores the use of natural plant extracts as a sustainable method to enhance the quality and safety of long-life sausages by incorporating them into natural edible casings. Ethanol (E) and aqueous (A) extracts of blackthorn (BT) and red cherry (RC), as well as their ethanol and water-based solutions, were prepared and analysed for their

antioxidant and antimicrobial properties. The analyses included the quantification of total phenols, non-flavonoids, flavonoids, flavonols, and anthocyanins, along with antioxidant activity assessments using FRAP, DPPH, and ABTS assays. Antimicrobial efficacy was tested against Gram-positive and Gram-negative bacteria (*Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, and *Salmonella enterica*) and mold *Penicillium expansum* via agar dilution methods to determine MIC and MBC/MFC.

Results showed that ethanol extracts had higher antioxidant activity than aqueous ones ($p < 0.05$), with the ethanol extract of blackthorn (EBT) containing the highest levels of phenolics (54.11 mg GAE/g d.e.) and exhibiting the strongest antioxidant, antimicrobial, and antifungal activities. Casings treated with EBTE (ethanol BT extract dissolved in ethanol) demonstrated significant antibacterial properties, particularly against Gram-negative bacteria. This study confirms that plant-extract-enriched natural casings can protect against oxidation and microbial spoilage, thereby enhancing the overall quality and safety of dry-cured sausages.

Keywords: plant extracts, edible casings, antioxidants, antimicrobial activity.

INTRODUCTION

The food industry has recently been searching for natural, safe, and economically profitable antioxidants and antimicrobial agents to replace existing synthetic additives. Plant extracts can be very beneficial in the food industry due to their potential as antimicrobial agents and antioxidants, as they are recognized as safe (GRAS, Generally Recognized as Safe) and do not have negative effects on human health. Their influence and

application in various foods, especially in meat and meat products (pork, beef, lamb), are being extensively studied [1], [2], [3].

Their effects should not adversely impact sensory properties (e.g., color, smell, or aroma), must be effective at low concentrations, be easy to use, remain stable during processing and storage, and, of course, should also be economically viable [3]. Plant extracts are primarily used to prevent the oxidation of fats and proteins, inhibit the growth and development of bacteria, yeasts, and molds, or prevent product spoilage. The antimicrobial and antioxidant activities of these substances are primarily attributed to their high content of phenolic compounds [4], which can extend shelf life, enhance oxidation resistance, slow the growth of microorganisms and molds, and thereby positively affect the properties of the product [5].

Wild forest fruits, mainly berries, represent one of the most popular and widespread groups of edible wild plants. Among the phytochemicals present in berries, polyphenolic compounds hold the most significant position, displaying strong antioxidant and notable antimicrobial activities [6]. Blackthorn (*Prunus spinosa*), as a rich source of phenols including phenolic acids, anthocyanins, and flavanols, is recognized in the literature as a source of antioxidants. Moreover, blackthorn demonstrates selective inhibition of the growth of certain potentially pathogenic bacterial strains. It is regarded as having significant biological importance as an antioxidant and microbiological agent and can find various applications in the food and pharmaceutical industries [7], [8], [9], [10]. Wild red cherry (*Prunus avium*) fruits are particularly rich in polyphenols (especially flavonoids, anthocyanins, and hydroxycinnamic acids) [11], and contain significant amount of anthocyanins that affect the overall antioxidant activity [12], [13], [14], [15].

Recent findings suggest that cherry extracts are effective against the growth of microorganisms, including both Gram-positive and Gram-negative bacteria, along with the understanding that cherries possess not only antioxidant properties but also antimicrobial properties [16]. Wild red cherries are

considered a promising functional food for human health [13].

By incorporating plant extracts or certain natural biopreservatives, films with antimicrobial and antioxidant properties can be created [17], [18]. The term "active" packaging refers to a material intended to release active components into food or absorb them from food with the goal of enhancing food sustainability while maintaining or improving packaging conditions. The use of edible coatings and films to preserve food quality has increased recently [2], [19]. The protective properties can be improved by adding antimicrobial agents or antioxidants. Edible films and coatings offer an opportunity to improve food quality, extend its shelf life, enhance safety, and increase functionality. They can be utilized as individual packaging materials, coatings for food, or carriers of active ingredients [20].

The aim of this work was to investigate the antioxidant and antimicrobial effects of blackthorn and red cherry extracts, as well as their influence on the properties of natural casing.

MATERIAL AND METHODS OF WORK

Extract preparation. Wild forest fruits (blackthorn - BT, and red cherry - RC) were purchased from the local market. First, fruits were washed, and the petioles and the seeds were removed. For extract, 40 g of fruits were homogenized with 160 mL of extragens (80% (v/v) ethanol - E, and distilled water - A), first on a Polytron PT 3100 homogenizer, for 10 minutes at 8000 rpm, then in an ultrasonic bath for 30 minutes, and 30 minutes on a magnetic stirrer. The mixture was filtered, and the obtained filtrate was evaporated to a dry residue, first on a vacuum evaporator and then in a dry sterilizer at 50°C. The dry extracts were stored in a dark until use.

Dry extracts analysis. The total phenolic content (TPC) was determined using the modified method of Folin-Ciocalteu [21]. The content of non-flavonoids (TN) was determined according to the formaldehyde method [22]. The content of flavonoids (TF) was calculated from the difference between the content of total phenols and non-flavonoids. The content of flavonols (F) was determined according to the method of

Velemir, A. et al. (2025). Antioxidant and antimicrobial potential of blackthorn and red cherry extracts in natural sausage casings. *STED Journal*, 7(2), 28-41.

Kumaran and Karunakaran [23]. For the determination of anthocyanins (monomeric anthocyanins - MA, total anthocyanins - TA, degradation index (ID) values) the pH differential and "single" pH methods were used [24]. The testing of antioxidant activity using the Ferric reducing/Antioxidant power (FRAP) assay was carried out by Benzie and Strain [25]; the 2,20-azinobis(3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt (ABTS) assay using the modified method of Re et al. [26] and the 2,2-diphenyl-1-picryl-hydrazyl (DPPH) assay using modified method of Liyana-Pathirana and Shahidi [27]. All the chemicals and reagents used were of analytical grade.

Extract solutions. Extracts were dissolved in 80% ethanol (v/v) (E) and in distilled water (W) to obtain solutions for further analysis (EBTE, EBTW, ABTE, ABTW, ERCE, ERCW, ARCE, ARCW)¹.

Extract solutions analysis. To determine the antibacterial activity of extracts against selected G⁺ (*Staphylococcus aureus* and *Bacillus cereus*) and G⁻ (*Escherichia coli* and *Salmonella enterica*) bacteria (minimum inhibitory - MIC, and minimum bactericidal - MBC concentrations), the agar dilution method was used [28], [29], [30]. To test the inhibition of the growth of the mycelium of the mold *Penicillium expansum*, the dilution method in agar was used [30] and the diameter of the mold growth was monitored (5 days).

Casing treatment. Based on the results of the antimicrobial tests, concentrations for casing treatment were determined for further analysis (EBTE, ABTE - 22.5g/L, ERCE, ERCW, ARCE - 30 g/L, EBTW - 45 g/L, ABTW - 90 g/L and ARCW - 120 g/L). Natural salted beef casings were soaked in water and washed of salt. For further analyses, the intestines were cut into pieces (5 cm long for antioxidant tests, 3.5x2.4 cm long for antimicrobial tests, dried and sterilized with a UV lamp for 30 minutes), submerged in extracts and kept for 24 hours on a shaker (SHO-2D, Witeg, Germany) at 120 rpm. After 24 hours of shaking, the casings were removed from the extracts, and dried at room temperature under sterile conditions.

¹etanolic-E/aqueous-A blackthorn BT/red cherry RC ekstrakt dissolved in ethanol-E/water-W

Casings analysis. The antioxidant activity of the casings was evaluated by TPC analysis, and FRAP, ABTS, and DPPH assays. To test the antimicrobial activity of the casing with the extract, the agar diffusion method was used [31].

Statistical analysis of the obtained results was performed using Microsoft Excel 2013 software package and the IBM SPSS Statistics 22.0 (Armonk, NY, United States). Results were presented as mean values of individual measurements $\pm$ standard deviations. The significance of differences between arithmetic means was determined and expressed with 95% probability (Tukey's test).

RESULTS AND DISCUSSION

Table 1 presents the average values of the phenolic compounds in extracts, confirming statistically significant differences between the samples for all evaluated parameters ($p < 0.05$), except TNF. The content of total phenols ranged from 14.83 to 54.11 mg GAE/g dry extract (ABT and EBT, respectively). Higher TPC content was obtained in ethanol extracts of all tested plants, as a result of better solubility of polyphenolic components in diluted ethanol compared to water, due to selective extraction of certain phenolic compounds [32]. Some authors report TPC values in blackthorn ranging from 8 to 20 mg GAE/g fresh fruit [33] [34].

For TPC in wild red cherry, the type of solvent had little influence. Serra et al. [13] consider that the phenolic composition of cherries includes flavonoids (anthocyanins, flavan-3-ols, and flavonols), hydroxycinnamic and hydroxybenzoic acids, with total TPC content ranging from 440 to 1300 mg/100 g dry matter.

Different concentrations of TNF (total non-flavonoids) and TF (total flavonoids) can be explained by the significant influence of various factors (location and cultivation technique, genotype, plant maturity, environmental conditions, climate, temperature, light) on the content of these substances in the plant [35].

Blackthorn extracts had higher flavonol content than red cherry (Table 1). Ruiz-Rodríguez et al. [7] report that flavonol content varies depending on the harvest year,

Velemir, A. et al. (2025). Antioxidant and antimicrobial potential of blackthorn and red cherry extracts in natural sausage casings. *STED Journal*, 7(2), 28-41.

and values ranged from 0.9 to 2.3 mg Rutin/g fresh blackthorn. The obtained flavonol content in wild red cherry compared to literature data is somewhat higher [11], [13].

Table 1. Content of total phenols (TPC), non-flavonoids (TNF), flavonoids (TF), and flavanols (F) in extracts

		TPC	TNF	TF	F
		(mg GAE/g d.e)		(mg QE/g d.e)	
BT	E	54.11 ^a	17.28 ^a	33.21 ^a	10.37 ^a
		±5.14	±6.05	±5.43	±0.38
	A	14.83 ^b	14.08 ^a	0.75 ^b	7.00 ^b
		±0.38	±0.17	±0.26	±0.97
RC	E	38.34 ^c	20.91 ^a	17.43 ^c	1.45 ^c
		±1.43	±3.22	±1.15	±0.51
	A	31.87 ^c	18.74 ^a	13.13 ^{bc}	1.47 ^c
		±1.55	±1.80	±1.02	±0.56

^{a-c} – different letters within the same column indicate statistically significant difference at $p < 0.05$ by Tukey's test

Table 2 presents the anthocyanin content, indicating that ethanol extracts exhibited significantly higher values ($p < 0.05$) compared to aqueous extracts, values for TA ranged from 3.65-37.48 mg/g d.e. (ABT and EBT, respectively). Pinacho et al. [36] state that

anthocyanin content depends on the polarity of the solvent used and report values for blackthorn of 165–180 mg malvidin glucoside equivalent/g. Similar values were reported by Ruiz-Rodríguez et al. [7].

Table 2. Content of monomeric (MA) and total (TA) anthocyanins in extracts (mg cyanidin-3-glucoside/g dry extract) and degradation index (ID) values

		MA	TA	ID
		(mg/g d.e)		
BT	E	8.33 ^a	37.48 ^a	4.50 ^a
		±0.02	±0.59	±0.08
	A	2.45 ^b	3.65 ^b	1.67 ^b
		±0.66	±0.54	±0.67
RC	E	6.43 ^c	12.96 ^c	2.04 ^b
		±0.93	±1.00	±0.14
	A	1.53 ^b	5.57 ^b	3.75 ^a
		±0.35	±0.45	±0.54

^{a-c} – different letters within the same column indicate statistically significant difference at $p < 0.05$ by Tukey's test

Total anthocyanin content in cherries, depending on the harvest location, ranged from 0.6 to 6.8 mg/g [37]. Various studies report differing anthocyanin contents, likely due to geographic differences and post-harvest factors such as storage conditions and extraction methods, with values ranging from 24-225 mg/100g [38]. Leichtweis et al. [39] suggest that ultrasound extraction and diluted ethanol can extract larger amounts of anthocyanins. Pliszka et al. [40] attribute the variations in degradation index (ID) values to differences between fruit species and extraction methods, both of which have a significant impact on anthocyanin stability.

Table 3 presents the results of the ABTS, DPPH, and FRAP assays, used to evaluate the antioxidant capacity of blackthorn and red cherry extracts. The strongest antioxidative activity in all tests was observed in the ethanol extract of blackthorn, while the aqueous extract of blackthorn showed relatively weak antioxidant activity, likely due to insufficient dissolution of polyphenolic compounds in the aqueous medium. The lowest activity was observed in aqueous extracts of red cherry (431.29 mg/L, 2588.14 mg/L and 58.97 $\mu\text{mol Fe}+2/\text{g d.e.}$, for ABTS, DPPH and FRAP, respectively).

Table 3. Antioxidant activity of extracts

		ABTS	DPPH	FRAP
		Ic50% (mg/L)		($\mu\text{mol Fe}^{+2}/\text{g d.e.}$)
BT	E	30.45 ^a	142.85 ^a	512.22 ^a
		± 1.33	± 7.69	± 9.80
	A	276.48 ^b	1571.63 ^b	107.51 ^b
		± 6.67	± 22.93	± 10.29
RC	E	187.26 ^c	950.32 ^c	216.59 ^c
		± 2.93	± 25.73	± 5.32
	A	431.29 ^d	2588.14 ^d	58.97 ^d
		± 14.97	± 157.03	± 13.07

^{a-d} – different letters within the same column indicate statistically significant difference at $p < 0.05$ by Tukey's test

Several studies have reported the antioxidant properties of blackthorn and wild cherry extracts, with notable differences depending on the extraction method and solvent used. Values of Ic50% for ethanol extracts of blackthorn reported by Veličković et al. [41] for DPPH were around 258 $\mu\text{g/mL}$, for ABTS about 184 $\mu\text{g/mL}$, while FRAP values were 0.10 $\mu\text{mol Fe}^{2+}/\text{g}$ dry matter. The same authors report values for aqueous extracts of blackthorn about 490 $\mu\text{g/mL}$ (DPPH), 217 $\mu\text{g/mL}$ (ABTS), and 0.01 $\mu\text{mol Fe}^{2+}/\text{g}$ dry matter (FRAP). Using aqueous ethanol and methanol solutions, and water on dry blackthorn, Tahirović et al. [9] report DPPH values of 140.80 $\mu\text{mol TE/g}$, ABTS 223.98 $\mu\text{mol TE/g}$, and FRAP 249.13 $\mu\text{mol TE/g}$. According to the same authors, 50% ethanol proved the best extraction solvent, while aqueous solutions showed the weakest activity.

Many authors believe that the content of polyphenolic compounds (phenols, anthocyanins) contributes to the overall antioxidant activity of wild red cherries [12], [42], while Serra et al. [13] report that in methanolic cherry extracts the most active substances with the best antioxidant properties are flavonoids (including catechin, epicatechin, quercetin, and anthocyanins) and derivatives of quinic acid (chlorogenic acid, neochlorogenic acid).

Analysis of cherries from Spain showed DPPH values of 242 $\mu\text{mol TE}/100$ g fresh fruit, ABTS 640 $\mu\text{mol TE}/100$ g fresh fruit, and FRAP 763 $\mu\text{M Fe}^{2+}/100$ g fresh fruit [43].

Different ripening stages also influence antioxidant activity, with ABTS values ranging from 317.92 mg TE/100 g fresh fruit in the early ripening stage to 439.10 mg TE/100 g fresh fruit in the final ripening stage [42]. Analysis of antioxidant activity in dark and light cherries from Turkey by Hayaloglu and Demir [14] indicate that darker cherries have stronger activity, which correlates with the anthocyanin content in the samples. The same authors report ABTS values of 4.5–6.15 mg TE/g fresh fruit, DPPH of 4.5–6.02 mg TE/g fresh fruit, and FRAP of 0.44–1.61 mg TE/g fresh fruit. Research has shown that bioactive compounds vary depending on the degree of ripeness and that with increased fruit color intensity, antioxidant activity increases [44].

As shown in Table 4, the minimum inhibitory concentration (MIC) of analyzed blackthorn extracts ranged from 7.5–30 g/L, and ethanol extract solutions (EBTE and EBTW) showed much better activity. MBC values for blackthorn extracts ranged from 15 to >120 g/L, with ABTW being the weakest. Red cherry extracts showed very weak antibacterial activity against selected G (+) bacteria. MIC values ranged from 30–120 g/L and 30–60 g/L (*S. aureus* and *B. cereus*, respectively). MBC values ranged from >30 to >120 g/L for *S. aureus* and 30–120 g/L for *B. cereus*. Considering the extract type and solvent, the best effect against selected bacteria was by ethanol extracts dissolved in ethanol, while aqueous extracts dissolved in water showed the weakest effect.

Table 4. Antibacterial activity of tested extracts against selected Gram-negative bacteria

<i>Staphylococcus aureus</i> ATCC 25923			<i>Bacillus cereus</i> WDCM 00151	
g/L	MIC	MBC	MIC	MBC
EBTE	7.5	30	7.5	15
EBTW	30	>30	15	15
ABTW	30	>120	30	60
ABTE	15	30	15	15
ERCE	30	>30	30	30
ERCW	>30	>30	30	>30
ARCW	120	>120	60	120
ARCE	30	>30	30	>30
Ampicillin 10 mg (mm)			11.50±2.32	
Ciprofloxacin 5 mg (mm)			29.10±4.41	
Erythromycin 15 mg (mm)			25.60±2.94	
Gentamicin 10 mg (mm)			23.30±2.14	

MIC values for Gram-negative bacteria (Table 5) of blackthorn extracts ranged from 15-60 g/L, and MBC values ranged from 30-120 g/L. The aqueous extract of blackthorn dissolved in water showed the weakest activity. Red cherry extracts did not show significant antibacterial activity against selected G (-) bacteria (MIC 30-120 g/L, MBC 30->120 g/L). Ethanol extracts dissolved in ethanol also showed stronger activity against G (-) bacteria, while aqueous extracts dissolved [8] in water had the weakest effect. These results align with previous findings.

Veličković [32] and Radovanović et al. [33] established that ethanol extracts of blackthorn show significant activity against

some bacteria (*S. abony*, *E. coli*, *P. aeruginosa*, and *S. aureus*). *B. subtilis* showed resistance to ethanol blackthorn extract [8]. Blackthorn extracts have significant biological importance both as antioxidants and antimicrobial agents, as confirmed by many authors [8], [33], [41]. Testing aqueous and ethanol cherry extracts on pure and clinical strains of *E. coli*, Rovčanin et al. [45] observed larger inhibition zones for the pure strain with ethanol extracts, as well as lower extract concentrations needed to inhibit this strain compared to clinical strains. Hanbali et al. [16] also note antimicrobial activity in wild red cherry extracts.

Table 5. Antibacterial activity of tested extracts against selected Gram-negative bacteria

<i>Escherichia coli</i> WDCM 00013			<i>Salmonella enterica</i> WDCM 00030	
g/L	MIC	MBC	MIC	MBC
EBTE	15	>30	15	30
EBTW	>30	>30	>30	>30
ABTW	60	120	60	60
ABTE	15	30	15	30
ERCE	30	>30	30	30
ERCW	>30	>30	>30	>30
ARCW	120	>120	120	>120
ARCE	30	>30	30	>30
Ampicillin 10 mg (mm)			22.20±2.64	
Ciprofloxacin 5 mg (mm)			36.60±5.43	
Erythromycin 15 mg (mm)			8.20±1.17	
Gentamicin 10 mg (mm)			24.60±3.38	

Many authors have shown that wild fruit extracts exhibit antibacterial activity against most tested G (+) and G (-) bacteria [32], [33]. G (+) bacteria are generally considered more susceptible to the inhibitory effects of plant extracts, likely due to structural differences in their cell walls compared to G (-) bacteria [46].

Figure 1 shows the effect of solutions on *P. expansum*. Solutions ranging from 3.75-30 g/L were tested, but lower concentrations (3.75 and 7.5 g/L) showed no activity. Aqueous solutions of all tested extracts did not exhibit antifungal activity. The EBTE solution showed activity at concentrations of 15 and 30 g/L, with mycelial growth inhibition (MGI) of 31.4% and 63.7%, respectively. Veličković et al. [41] report that the aqueous blackthorn extract had slightly better antifungal properties than the ethanol extract, but its effect was

significantly weaker than commercially used antimycotics. Gegiu et al. [47] state that blackthorn extracts have no antifungal activity. ERCE and ARCE solutions showed activity at a concentration of 30 g/L, while other tested concentrations showed no activity against the selected mold. The ERCE solution demonstrated inhibitory activity (MGI of 63.3%) at 30 g/L. The solution of EBTE, in concentration 15 g/L showed a steady increase but very weak activity. Results from Hanbali et al. [16] confirm a measurable effect of red cherry extracts on the tested molds. The ARCE solution showed significant inhibitory activity at 30 g/L (MGI of 54.3%). For red cherry extract solutions ERCW and ARCW, the diameter increased with concentration, making these extracts also suitable environments for the development of *P. expansum* mold.

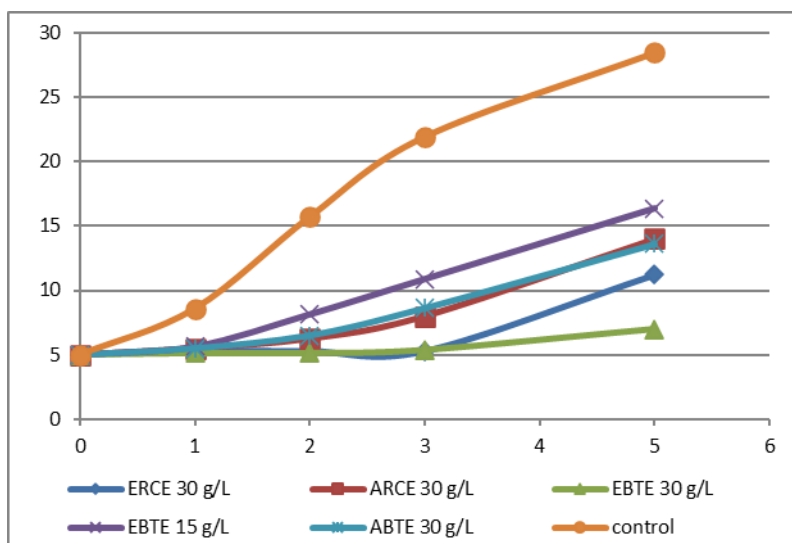


Figure 1. Antifungal activity of extracts against the mold *P. expansum*

The antimicrobial activity of the tested extracts is largely related to the quantity and structure of extracted compounds. The antimicrobial activity of plant extracts is often associated with polyphenolic compounds that also exhibit antioxidant effects. Numerous authors attribute strong antimicrobial properties to phenolic compounds, anthocyanins, iridoids, tannins, and other related substances[8], [10], [48].

Results of the total phenolic content and antioxidant activity (DPPH, ABTS and FRAP tests) for treated casings are presented in Table 6. After treatment of the casings with selected extract solutions, EBTE had the highest TPC (3.07 mg GAE/g), and ARCW the lowest (0.30 mg GAE/g). According to DPPH radical assay, ERCE had the best activity, and ABTE the weakest, while according to ABTS assay, ARCE showed the best activity (182.02 μ g

Velemir, A. et al. (2025). Antioxidant and antimicrobial potential of blackthorn and red cherry extracts in natural sausage casings. *STED Journal*, 7(2), 28-41.

GAE/g) and ABTE the weakest (53.95 μ g GAE/g). FRAP test values ranged from 2.41-10.08 μ mol Fe²⁺/g (ABTE and ERCE, respectively). Although numerous studies confirm the positive effects of natural polyphenols obtained from various plant materials, limited information is available on

the impact of edible films incorporating natural plant extracts [49]. Biologically derived active substances have strong antioxidant and antimicrobial effects, low toxicity, and are considered effective agents for active packaging used in food preservation and conservation [50].

Table 6. The total phenolic content and antioxidant activity (DPPH, ABTS and FRAP tests) of treated casings

	TPC	DPPH	ABTS	FRAP
	mg GAE/g	μ gGAE/g		μ mol Fe ²⁺ /g
EBTE	3.07 ^a ± 0.32	128.95 ^{ab} ± 1.65	134.26 ^{ab} ±1.01	7.24 ^{ab} ± 0.46
EBTW	1.94 ^b ± 0.06	159.80 ^a ± 2.26	132.75 ^{ab} ± 2.11	6.14 ^{ac} ± 0.01
ABTW	2.07 ^b ± 0.05	84.99 ^b ± 1.07	105.81 ^{abc} ±2.02	6.15 ^{ac} ± 0.59
ABTE	1.02 ^b ± 0.21	28.24 ^c ± 1.89	53.95 ^c ± 2.08	2.41 ^d ± 0.44
ERCE	0.34 ^d ± 0.08	167.75 ^a ± 2.83	175.35 ^b ± 3.05	10.08 ^b ± 1.65
ERCW	1.88 ^b ± 0.18	133.51 ^a ± 2.44	129.56 ^{abc} ± 2.18	7.89 ^{ab} ± 0.94
ARCW	0.30 ^d ± 0.05	148.18 ^a ± 2.12	182.02 ^b ± 4.21	9.98 ^b ± 1.29
ARCE	2.35 ^b ± 0.13	34.76 ^c ± 1.15	66.52 ^{ac} ± 1.31	3.88 ^{cd} ± 1.04

a-d – different letters within the same column indicate statistically significant difference at p < 0.05 by Tukey's test

Nazmi and Sarbon [51] state that total phenolic content (TPC) in protective coatings or composites (films) correlates with phenol content in the used extracts, and their study of *C. asiatica* extract showed a strong relationship between phenolic compounds and antioxidant activity. The same authors claim that the total phenol content in films increases with extract concentration, also supported by Shojaee-Aliabadi et al. [52]. In their work with gelatin-based films enriched with *C. asiatica* extract, Nazmi and Sarbon [51] report strong DPPH activity, attributing this to phenolic compounds including flavonoids, phenolic acids, and tannins. Pires et al. [53] during analysis of various essential oils added to films, observed the increase DPPH values, especially in films with coriander and citronella oils. Peighambardoust et al. [54] note that adding antioxidants to films significantly increases their DPPH values,

although antioxidant activity and thermal stability of antioxidants differ, as confirmed by analysis of various composite films with synthetic antioxidants (BHT, BHA, sorbic acid). Many authors confirm that increasing antioxidant additives (essential oils) raises DPPH values [52] [55]. Teixeira et al. [56] argue that increased DPPH activity in fish protein films is due to the incorporation of essential oils, noting differences in antioxidant activity depending on the type of essential oil used, which is attributed to interactions between film components and essential oils and/or loss of volatile compounds during film drying.

Several authors agree that the addition of antioxidants (various essential oils or extracts) increases ABTS activity in films (chitosan, gelatin, fish proteins), mainly linked to the presence of phenols, flavonoids, and sulfur-containing compounds [57], [58].

FRAP values confirm that adding antioxidants enhances film activity, and it is considered that the amount of antioxidant added is proportional to the antioxidant activity of edible films [51]. Eça et al. [59] provide examples of significant increases in antioxidant activity of films (fish skin gelatin, chitosan, etc.) with antioxidant addition (various essential oils) as measured by DPPH and FRAP assays.

None of the casings with blackthorn extract solutions showed activity against G (+) *S. aureus* and *B. cereus*. Against G (-) bacteria, ABTW, ABTE, and EBTE exhibit contact inhibition (C.I.) on *S. enterica*, and only the casing treated with ABTW showed inhibition against *E. coli*. No casing showed any activity against *P. expansum* mold (n.a.). Although all casings used extract concentrations above the measured MIC values for certain extracts, it is assumed that the casing retained less than the required amount to act on the selected strains. No casing treated with red cherry extract solutions showed any activity against tested bacteria, or *P. expansum*.

The obtained results do not align with antioxidant activity measurements of the extracts, where casings treated with plant extracts show a positive influence on antioxidant properties. This indicates that the antimicrobial properties of plant extracts may be attributed to individual or synergistic effects of various factors, not only the phenolic content. A limitation of the agar diffusion method is the relatively long incubation time needed to detect inhibition zones, which can lead to loss of volatile or thermally unstable agents, likely causing the absence of antibacterial activity in tested samples. It is also impossible to quantify the amount of antimicrobial agent diffusing into the agar medium due to the gradient and matrix network of the agar used [30]. Pires et al. [53] report that varying antimicrobial activity was due to differences in active substances in agents (essential oils, plant extracts), interactions between agent compounds and films (soy, alginate-apple puree, alginate, and whey protein), and differences in agent quantity per film surface area. A possible explanation is that thinner

film samples do not release sufficient amounts of the active agent to inhibit microbial growth [54], [56]. Shojaee-Aliabadi et al. [52] state that antibacterial activity is directly proportional to the agent concentration, consistent with our research and results.

CONCLUSIONS

Edible casings treated with various plant extracts showed significant differences in antioxidant performance, EBTE had the highest total phenolic content (TPC), while ERCE displayed the best antioxidant activity in DPPH and FRAP assays. However, antimicrobial effects were limited, only some casings inhibited specific Gram-negative bacteria, with no activity against Gram-positive strains or molds. These results suggest that antimicrobial activity depends on more than phenolic content alone, possibly involving complex synergistic interactions and the nature of the film matrix. The amount of extract retained and its interaction with the film material significantly influence antimicrobial efficacy. While natural plant extracts effectively boost antioxidant capacity, optimizing antimicrobial performance requires further research into extract concentration, film composition, and application methods.

Packaging infused with natural antioxidants and antimicrobials presents a promising approach to food preservation. By integrating these agents into edible films or coatings, oxygen transmission is reduced, and the structural and functional properties of the packaging are improved. Such active packaging systems not only help prevent oxidation but also enhance sensory quality and shelf life.

In the meat industry, this strategy represents a modern alternative to synthetic additives, providing an innovative and more natural method for extending the freshness of meat and its products.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURE

1. Ibrahim, H. M., Abou-Arab, A. A., & Salem, F. M. A. (2011). Antioxidant and antimicrobial effect of some natural plant extracts added to lamb patties during storage. *Grasas y Aceites*, 62(2), 139-148. <https://doi.org/10.3989/gya.066510>
2. Hromiš, N. M., Šojić, B. V., Škaljac, S. B., Lazić, V. L., Džinić, N. R., Šuput, D. Z., & Popović, S. Z. (2013). Effect of chitosan-caraway coating on color stability and lipid oxidation of traditional dry fermented sausage. *Acta Periodica Technologica*, 44, 57-65. <https://doi.org/10.2298/APT1344057H>
3. Nikmaram, N., Budaraju, S., Barba, F. J., Lorenzo, J. M., Cox, R. B., Mallikarjunan, K., & Roohinejad, S. (2018). Application of plant extracts to improve the shelf-life, nutritional and health-related properties of ready-to-eat meat products. *Meat Science*, 145, 245-255. <https://doi.org/10.1016/j.meatsci.2018.06.031>
4. Botsaris, G., Orphanides, A., Yiannakou, E., Gekas, V., & Goulas, V. (2015). Antioxidant and Antimicrobial Effects of *Pistacia lentiscus* L. Extracts in Pork Sausages. *Food Technology and Biotechnology*, 53(4), 472-478. <https://doi.org/10.17113/ftb.53.04.15.4051>
5. Alhijazeen, M. (2014). *Effect of oregano essential oil and tannic acid on storage stability and quality of ground chicken meat*. Dissertation. Ames, Iowa: Iowa State University. <https://doi.org/10.31274/etd-180810-3323>
6. Šarić, B. (2016). *Iskorišćenje tropa borovnice i maline u formulaciji bezglutenskog keksa sa dodatkom vrednošću*. Doktorska disertacija. Novi Sad, Srbija: Univerzitet u Novom Sadu, Tehnološki fakultet. <https://nardus.mpn.gov.rs/handle/123456789/6985>
7. Ruiz-Rodríguez, B. M., Ancos, B. de, Sánchez-Moreno, C., Fernández-Ruiz, V., Sánchez-Mata, M. de C., Cámara, M., & Tardío, J. (2014). Wild blackthorn (*Prunus spinosa* L.) and hawthorn (*Crataegus monogyna* Jacq.) fruits as valuable sources of antioxidants. *Fruits*, 69(1), 61-73. <https://doi.org/10.1051/fruits/2013102>
8. Veličković, J. M., Kostić, D. A., Stojanović, G. S., Mitić, S. S., Mitić, M. N., Randelović, S. S., & Đorđević, A. S. (2014). Phenolic composition, antioxidant and antimicrobial activity of the extracts from *Prunus spinosa* L. fruit. *Hemijaska Industrija*, 68(3), 297-303. <https://doi.org/10.2298/HEMIND130312054V>
9. Tahirović, A., Bašić, N., & Čopra-Janićijević, A. (2018). Effect of solvents on phenolic compounds extraction and antioxidant activity of *Prunus spinosa* L. fruits. *Bulletin of the Chemists and Technologists of Bosnia and Herzegovina*, 50, 19-24. https://hemija.pmf.unsa.ba/glasnik/files/Issue%2050/5-19-24-Tahirovi_A.pdf
10. Pozzo, L., Russo, R., Frassinetti, S., Vizzarri, F., Árvay, J., Vornoli, A., Casamassima, D., Palazzo, M., Della Croce, C. M., & Longo, V. (2020). Wild italian *Prunus spinosa* L. fruit exerts in vitro antimicrobial activity and protects against in vitro and in vivo oxidative stress. *Foods*, 9(1), 5. <https://doi.org/10.3390/foods9010005>
11. Gonçalves, J., Ramos, R., Luís, Á., Rocha, S., Rosado, T., Gallardo, E., & Duarte, A. P. (2019). Assessment of the Bioaccessibility and Bioavailability of the Phenolic Compounds of *Prunus avium* L. by in Vitro Digestion and Cell Model. *ACS Omega*, 4, 7605-7613. <https://doi.org/10.1021/acsomega.8b03499>
12. González-Gómez, D., Lozano, M., Fernández-León, M. F., Bernalte, M. J., Ayuso, M. C., & Rodríguez, A. B. (2010). Sweet cherry phytochemicals: Identification and characterization by HPLC-DAD/ESI-MS in six sweet-cherry cultivars grown in Valle del Jerte (Spain). *Journal of Food Composition and Analysis*, 23(6), 533-539. <https://doi.org/10.1016/j.jfca.2009.02.008>
13. Serra, A. T., Duarte, R. O., Bronze, M. R., & Duarte, C. M. M. (2011). Identification of bioactive response in traditional cherries from Portugal. *Food Chemistry*, 125(2),

Velemir, A. et al. (2025). Antioxidant and antimicrobial potential of blackthorn and red cherry extracts in natural sausage casings. *STED Journal*, 7(2), 28-41.

- 318–325.
<https://doi.org/10.1016/j.foodchem.2010.07.088>
14. Hayaloglu, A. A., & Demir, N. (2015). Physicochemical characteristics, antioxidant activity, organic acid and sugar contents of 12 sweet cherry (*Prunus avium* L.) cultivars grown in Turkey. *Journal of Food Science*, 80(3), C564-570.
<https://doi.org/10.1111/1750-3841.12781>
 15. Iglesias-Carres, L., Mas-Capdevila, A., Bravo, F. I., Mulero, M., Muguerza, B., & Arola-Arnal, A. (2019). Optimization and characterization of Royal Dawn cherry (*Prunus avium*) phenolics extraction. *Scientific Reports*, 9(1), 17626.
<https://doi.org/10.1038/s41598-019-54134-w>
 16. Hanbali, L. B., Amiry, J. G., Ghadieh, R. M., Hasan, H. A., Koussan, S. S., Nakhal, Y. K., Tarraf, A. M., & Haddad, J. J. (2012). The Antimicrobial Activity of Sweet Cherry (*Prunus avium*) Extracts: II. Measurement of Sensitivity and Attenuation of Gram-Positive and Gram-Negative Bacteria and *C. albicans* in Culture. *Current Nutrition & Food Science*, 8(4), 292–303.
<https://doi.org/10.2174/157340112803832174>
 17. Raeisi, M., Tabaraei, A., Hashemi, M., & Behnampour, N. (2016). Effect of sodium alginate coating incorporated with nisin, *Cinnamomum zeylanicum*, and rosemary essential oils on microbial quality of chicken meat and fate of *Listeria monocytogenes* during refrigeration. *International Journal of Food Microbiology*, 238, 139–145.
<https://doi.org/10.1016/j.ijfoodmicro.2016.08.042>
 18. Król, Ż., Kulig, D., Marycz, K., Zimoch-Korzycka, A., & Jarmoluk, A. (2017). The effects of using sodium alginate hydrosols treated with direct electric current as coatings for sausages. *Polymers*, 9(11), 602.
<https://doi.org/10.3390/polym9110602>
 19. Özvural, E. B., Huang, Q., & Chikindas, M. L. (2016). The comparison of quality and microbiological characteristic of hamburger patties enriched with green tea extract using three techniques: Direct addition, edible coating and encapsulation. *LWT - Food Science and Technology*, 68, 385–390.
<https://doi.org/10.1016/j.lwt.2015.12.036>
 20. Galić, K. (2009). Jestiva ambalaža u prehrambenoj industriji. *Hrvatski časopis za prehrambenu tehnologiju, biotehnologiju i nutricionizam*, 4(1–2), 23–31.
 21. Wolfe, K., Wu, X., & Liu, R. H. (2003). Antioxidant Activity of Apple Peels. *Journal of Agricultural and Food Chemistry*, 51(3), 609–614.
<https://doi.org/10.1021/jf020782a>
 22. Alberto, M. R., Rinsdahl Canavosio, M. A., & Manca de Nadra, M. C. (2006). Antimicrobial effect of polyphenols from apple skins on human bacterial pathogens. *Electronic Journal of Biotechnology*, 9(3), 205-209. <https://doi.org/10.4067/S0717-34582006000300006>.
 23. Kumaran, A., & Joel Karunakaran, R. (2007). In vitro antioxidant activities of methanol extracts of five *Phyllanthus* species from India. *LWT - Food Science and Technology*, 40(2), 344–352.
<https://doi.org/10.1016/j.lwt.2005.09.011>
 24. Lee, J., Durst, R., & Wrolstad, R. (2005). Determination of total monomeric anthocyanin pigment content of fruit juices, beverages, natural colorants, and wines by the pH differential method: Collaborative Study. *Journal of AOAC International*, 88(5), 1269–1278.
 25. Benzie, I. F. F., & Strain, J. J. (1996). The Ferric Reducing Ability of Plasma (FRAP) as a Measure of “Antioxidant Power”: The FRAP Assay. *Analytical Biochemistry*, 239(1), 70–76.
<https://doi.org/10.1006/abio.1996.0292>
 26. Re, R., Pellegrini, N., Proteggente, A., Pannala, A., Yang, M., & Rice-Evans, C. (1999). Antioxidant activity applying an improved ABTS radical cation decolorization assay. *Free Radical Biology & Medicine*, 26(9–10), 1231–1237.
[https://doi.org/10.1016/s0891-5849\(98\)00315-3](https://doi.org/10.1016/s0891-5849(98)00315-3)
 27. Liyana-Pathirana, C. M., & Shahidi, F. (2005). Antioxidant activity of commercial soft and hard wheat (*Triticum aestivum* L.)

Velemir, A. et al. (2025). Antioxidant and antimicrobial potential of blackthorn and red cherry extracts in natural sausage casings. *STED Journal*, 7(2), 28-41.

- as affected by gastric pH conditions. *Journal of Agricultural and Food Chemistry*, 53(7), 2433–2440.
<https://doi.org/10.1021/jf049320i>
28. Escmid, E. (2000). Determination of minimum inhibitory concentrations (MICs) of antibacterial agents by agar dilution. *Clinical Microbiology and Infection*, 6(9), 509–515. <https://doi.org/10.1046/j.1469-0691.2000.00142.x>
29. Wiegand, I., Hilpert, K., & Hancock, R. E. W. (2008). Agar and broth dilution methods to determine the minimal inhibitory concentration (MIC) of antimicrobial substances. *Nature Protocols*, 3(2), 163–175.
<https://doi.org/10.1038/nprot.2007.521>
30. Balouiri, M., Sadiki, M., & Ibensouda, S. K. (2016). Methods for in vitro evaluating antimicrobial activity: A review. *Journal of Pharmaceutical Analysis*, 6(2), 71–79.
<https://doi.org/10.1016/j.jpha.2015.11.005>
31. Pinho, E., Magalhães, L., Henriques, M., & Oliveira, R. (2011). Antimicrobial activity assessment of textiles: Standard methods comparison. *Annals of Microbiology*, 61(3), 493–498.
<https://doi.org/10.1007/s13213-010-0163-8>
32. Veličković, J. (2013). *Hemijska analiza i antioksidativna aktivnost ekstraktata odabranih biljnih vrsta bogatih fenolnim jedinjenjima*. Doktorska disertacija. Niš, Srbija: Univerzitet u Nišu, Prirodno-matematički fakultet, departman za hemiju.
33. Radovanović, B. C., Anđelković, S. M., Radovanović, A. B., & Anđelković, M. Z. (2013). Antioxidant and antimicrobial activity of polyphenol extracts from wild berry fruits grown in southeast Serbia. *Tropical Journal of Pharmaceutical Research*, 12(5), 813–819.
<https://doi.org/10.4314/tjpr.v12i5.23>
34. Bajić-Ljubičić, J. (2018). *Varijabilnost sadržaja odabranih fenolnih jedinjenja u ekstraktima plodova pet šumskih drvenastih vrsta sa različitih staništa u Srbiji*. Doktorska disertacija. Beograd, Srbija: Univerzitet u Beogradu.
<https://nardus.mpn.gov.rs/handle/123456789/11243>
35. Simić, V. M. (2018). *Optimizacija mikrotalasne ekstrakcije polifenolnih jedinjenja iz ploda aronije (Aronia melanocarpa L.)*. Doktorska disertacija. Niš, Srbija: Univerzitet u Nišu, Tehnološki fakultet u Leskovcu.
<https://nardus.mpn.gov.rs/handle/123456789/10438>
36. Pinacho, R., Caverio, R. Y., Astiasarán, I., Ansorena, D., & Calvo, M. I. (2015). Phenolic compounds of blackthorn (*Prunus spinosa* L.) and influence of in vitro digestion on their antioxidant capacity. *Journal of Functional Foods*, 19, 49–62.
<https://doi.org/10.1016/j.jff.2015.09.015>
37. Rimpapa, Z., Toromanovic, J., Tahirovic, I., Šapčanin, A., & Sofic, E. (2007). Total content of phenols and anthocyanins in edible fruits from Bosnia. *Bosnian Journal of Basic Medical Sciences*, 7(2), 119–122.
<https://pubmed.ncbi.nlm.nih.gov/articles/PMC5747280/>
38. Blackhall, M. L., Berry, R., Davies, N. W., & Walls, J. T. (2018). Optimized extraction of anthocyanins from Reid Fruits' *Prunus avium* 'Lapins' cherries. *Food Chemistry*, 256, 280–285.
<https://doi.org/10.1016/j.foodchem.2018.02.137>
39. Leichtweis, M. G., Pereira, C., Prieto, M. A., Barreiro, M. F., Baraldi, I. J., Barros, L., & Ferreira, I. C. F. R. (2019). Ultrasound as a rapid and low-cost extraction procedure to obtain anthocyanin-based colorants from *Prunus spinosa* L. fruit epicarp: Comparative study with conventional heat-based extraction. *Molecules*, 24(3), 573.
<https://doi.org/10.3390/molecules24030573>
40. Pliszka, B., Huszcza-Ciołkowska, G., Januszewicz, E., & Warminska-Radyko, I. (2013). Stability, microbiological quality, and antioxidant properties of extracts from berry fruits. *Acta Alimentaria*, 42(2), 256–263.
<https://doi.org/10.1556/aalim.42.2013.2.13>
41. Veličković, I., Zizak, Z., Rajcevic, N., Ivanov, M., Soković, M., Marin, P., & Grujić, S. (2020). Examination of the polyphenol content and bioactivities of *Prunus spinosa* L. fruit extracts. *Archives of Biological Sciences*, 72, 1–18.

Velemir, A. et al. (2025). Antioxidant and antimicrobial potential of blackthorn and red cherry extracts in natural sausage casings. *STED Journal*, 7(2), 28-41.

- <https://doi.org/10.2298/ABS191217004V>
42. Serradilla, M. J., Lozano, M., Bernalte, M. J., Ayuso, M. C., López-Corrales, M., & González-Gómez, D. (2011). Physicochemical and bioactive properties evolution during ripening of 'Ambrunés' sweet cherry cultivar. *LWT - Food Science and Technology*, 44(1), 199–205.
<https://doi.org/10.1016/j.lwt.2010.05.036>
 43. Ruiz-Torralba, A., Guerra-Hernández, E., & Garcia-Villanova, B. (2018). Antioxidant capacity, polyphenol content and contribution to dietary intake of 52 fruits sold in Spain. *CyTA - Journal of Food*, 16, 1131–1138.
<https://doi.org/10.1080/19476337.2018.1517828>
 44. Aglar, E., Saracoglu, O., Karakaya, O., Ozturk, B., & Gun, S. (2019). The relationship between fruit color and fruit quality of sweet cherry (*Prunus avium* L. cv. '0900 Ziraat'). *Turkish Journal of Food and Agriculture Sciences*, 1(1), 1-5.
 45. Rovčanin, B. R., Tatjana, Steševi, D., Keki, D., & Risti, M. (2015). Antibacterial effect of *Herniaria hirsuta*, *Prunus avium*, *Rubia tinctorum* and *Sempervivum tectorum* plant extracts on multiple antibiotic resistant. *Escherichia coli*. *Bioscience Journal*, 31(6), 1852-1861.
<https://doi.org/10.14393/BJ-v31n6a2015-29091>
 46. Turker, A., Yildirim, A., & Karakaş, F. (2014). Antibacterial and antitumor activities of some wild fruits grown in Turkey. *Biotechnology & Biotechnological Equipment*, 26, 2765–2772.
<https://doi.org/10.5504/BBEQ.2011.0156>
 47. Gegiu, G., Branza, A.-D., Bucur, L., Grigorian, M., Tache, T., & Badea, V. (2015). Contributions to the antimicrobial and antifungal study of the aqueous extract of *Prunus spinosa* L. *Farmacia*, 63, 275–279.
 48. Radulović, N. S., Blagojević, P. D., Stojanović-Radić, Z. Z., & Stojanović, N. M. (2013). Antimicrobial plant metabolites: Structural diversity and mechanism of action. *Current Medicinal Chemistry*, 20(7), 932–952
 49. Mohd Azman, N. A., Gallego, M. G., Segovia, F., Abdullah, S., Shaarani, S. M., & Almajano Pablos, M. P. (2016). Study of the properties of bearberry leaf extract as a natural antioxidant in model foods. *Antioxidants*, 5(2), 11.
<https://doi.org/10.3390/antiox5020011>
 50. Dobrucka, R., & Cierpiszewski, R. (2014). Active and Intelligent Packaging Food-Research and Development - A Review. *Polish Journal of Food and Nutrition Sciences*, 64(1), 7–15.
<https://doi.org/10.2478/v10222-012-0091-3>
 51. Nazmi, N. N. M., & Sarbon, N. (2019). Characterization on antioxidant and physical properties of gelatin based composite films with incorporation of *Centella asiatica* (pegaga) extract. *Food Research*, 4, 224–233.
[https://doi.org/10.26656/fr.2017.4\(1\).243](https://doi.org/10.26656/fr.2017.4(1).243)
 52. Shojaee-Aliabadi, S., Hosseini, H., Mohammadifar, M. A., Mohammadi, A., Ghasemlou, M., Ojagh, S. M., Hosseini, S. M., & Khaksar, R. (2013). Characterization of antioxidant-antimicrobial κ-carrageenan films containing *Satureja hortensis* essential oil. *International Journal of Biological Macromolecules*, 52, 116–124.
<https://doi.org/10.1016/j.ijbiomac.2012.08.026>
 53. Pires, C., Ramos, C., Teixeira, B., Batista, I., Nunes, M. L., & Marques, A. (2013). Hake proteins edible films incorporated with essential oils: Physical, mechanical, antioxidant and antibacterial properties. *Food Hydrocolloids*, 30(1), 224–231.
<https://doi.org/10.1016/j.foodhyd.2012.05.019>
 54. [54] Peighambardoust, S. H., Fasihnia, S. H., Peighambardoust, S. J., Pateiro, M., Domínguez, R., & Lorenzo, J. M. (2021). Active Polypropylene-Based Films Incorporating Combined Antioxidants and Antimicrobials: Preparation and Characterization. *Foods* (Basel, Switzerland), 10(4), 722.
<https://doi.org/10.3390/foods10040722>
 55. Salarbashi, D., Tajik, S., Shojaee-Aliabadi, S., Ghasemlou, M., Moayyed, H., Khaksar, R., & Noghabi, M. S. (2014). Development of new active packaging film made from a soluble soybean

Velemir, A. et al. (2025). Antioxidant and antimicrobial potential of blackthorn and red cherry extracts in natural sausage casings. *STED Journal*, 7(2), 28-41.

- polysaccharide incorporated *Zataria multiflora* Boiss and *Mentha pulegium* essential oils. *Food Chemistry*, 146, 614–622.
<https://doi.org/10.1016/j.foodchem.2013.09.014>
56. Teixeira, B., Marques, A., Pires, C., Ramos, C., Batista, I., Saraiva, J. A., & Nunes, M. L. (2014). Characterization of fish protein films incorporated with essential oils of clove, garlic and origanum: Physical, antioxidant and antibacterial properties. *LWT - Food Science and Technology*, 59(1), 533–539.
<https://doi.org/10.1016/j.lwt.2014.04.024>
57. Jahani, S., Shakiba, A., & Azami, M. (2014). Functional properties, antibacterial and antioxidant activities of *Zataria multiflora* encapsulated in gelatin nanofilms. *The Journal of Microbiology, Biotechnology and Food Sciences*, 4(2), 88-92.
<https://doi.org/10.15414/jmbfs.2014.4.2.88-92>
58. Tongnuanchan, P., Benjakul, S., & Prodpran, T. (2012). Properties and antioxidant activity of fish skin gelatin film incorporated with citrus essential oils. *Food Chemistry*, 134(3), 1571–1579.
<https://doi.org/10.1016/j.foodchem.2012.03.094>
59. Eça, K. S., Sartori, T., & Menegalli, F. C. (2014). Films and edible coatings containing antioxidants—A review. *Brazilian Journal of Food Technology*, 17, 98–112.
<https://doi.org/10.1590/bjft.2014.017>

THE IMPACT OF ECONOMIC AND EDUCATIONAL STATUS ON ORGANIC FOOD PURCHASING: A FOCUS ON ONLINE CONSUMERS

Jovana Galić

University of Novi Sad, Faculty of Economics, Segedinski put 9-11, 24 000 Subotica, Serbia,
jovana.galic@gmail.com

ORIGINAL SCIENTIFIC PAPER

ISSN 2637-2150

e-ISSN 2637-2614

DOI 10.63395/STEDJournal0702088G42

UDC 631.147:366.5(497.6)

COBISS.RS-ID 143560193

Received: 10 October 2025.

Revised: 03 November 2025.

Accepted: 19 November 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Corresponding Author: Jovana Galić,
University of Novi Sad, Faculty of Economics,
Segedinski put 9-11, 24 000 Subotica, Serbia,
jovana.galic@gmail.com



Copyright © 2024 Jovana Galić
published by UNIVERSITY PIM. This work
licensed under the Creative Commons
Attribution-NonCommercial-NoDerivs 4.

Citation: Galić, J. (2025). The impact of economic and educational status on organic food purchasing: a focus on online consumers. *STED Journal*, 7(2), 42-41.
<https://doi.org/10.63395/STEDJournal0702088G42>

ABSTRACT

The aim of this research is to examine the impact of consumers economic and educational status on the frequency of organic food purchases through all available distribution channels, with focus on online channels. The research was conducted via online questionnaire and based on sample of 358 respondents from the territory of Republic of Srpska. The results showed that 86% of

respondents buy or occasionally buy organic food, while 14% respond they never purchase organic food. Using Kruskal-Wallis test, a positive and statistically significant relation was identified between the level of education and the frequency of organic food purchases, regardless of the distribution channel, while household income did not show a significant relation. When online organic food purchases were analyzed specifically, neither the level of education or household income had a statistically significant impact, although a slight trend was observed for education level, which may be relevant for future research.

Keywords: organic food, consumer behavior, education, income, online shopping

INTRODUCTION

The growing organic food production and consumption has been a prominent topic in scientific research papers over the past decades. In contemporary society, awareness of the importance of healthy nutrition, environmental protection and sustainable production is becoming increasingly pronounced, with organic food production being grounded precisely on these principles. This type of production offers numerous benefits for human health, environmental protection and sustainable agriculture in general, as it seeks to ensure the long-term preservation of soil, water and biodiversity. Organic products are products cultivated without the use of artificial fertilizers, pesticides, additives or genetically modified organisms. Compared to conventional farming, the organic production is more demanding, often resulting in lower yields and higher product prices.

Although interest in organic food in Bosnia and Herzegovina is rising [1] the factors influencing consumers decisions

regarding its consumption remain diverse and without researcher's consensus. Previous studies most frequently emphasize education attainment, household income level and food availability as a key determinant of purchasing behavior. Consumers habits are reshaped by online commerce expansion, with COVID – 19 pandemics serving as a strong incentive for the use of this distribution channel.

When it comes to the organic food market in the Republic of Srpska, the digital context of organic food consumption has been insufficiently investigated. Therefore, the primary aim of this paper is to examine the role of selected socio-demographic indicators – primarily the level of consumer education and household income related to the consumer decision to purchase organic food, with special focus on online consumers.

LITERATURE REVIEW

Numerous socio-demographic and situational studies have examined the various advantages and barriers associated with purchasing organic food, placing particular emphasis on factors such as consumers level of education, price of organic food and market availability.

Education – the organic food consumption is often in significant and positive relation to a level of consumer education [2], [3], [4]. Those consumers with higher level of education have generally more awareness and pay more attention to a healthy lifestyle. Consequently, they highlight the benefits of consuming organic food as health and environment welfare [5], [6].

Price – due to specific production requirements, organic food is more expensive than conventionally grown. Although some consumers are willing to pay premium price for organic food [6], relatively high prices are one of limiting factors in purchase decisions [7], [5], [8], [9]. Consequently, organic food buyers are more likely to belong to households with higher income levels [2], [6].

Availability – another most often barrier to purchasing organic food relates to insufficient supply and limited market availability [7], [2], [8], [10].

Solution to overcoming the mentioned barriers should be in alternative distribution

channels that would enable easier accessibility of organic products and facilitate price comparability. Online shopping offers certain advantages over conventional instore shopping. This form of purchase allows consumers to compare product prices and browse a wide range of available items [11] with convenience, practicality and time efficiency serving as motivating factors [12]. Agricultural products are no exception to online trade; however, research indicates that digital marketing in this sector is still in its early stages of development [13].

The COVID-19 pandemic fundamentally changed consumer behavior [14], [15], forcing many people to adopt online shopping practices [16]. In Serbia, this shift resulted in a growing number of consumers purchasing organic food online [17], although their share within the overall sample remained relatively small and like findings in Romania [18]. In Bosnia and Herzegovina, customers are becoming increasingly accepting the Internet technologies and e-commerce [19] stating that the dominant reason for making a purchase decision are a positive experience with the manufacturer/seller while the lack of trust is still an issue especially when it comes to online payments.

To gain a better understanding of the online organic food market, it is necessary to deepen knowledge about its users [20], especially their socio-demographic profiles and the reason that have influence on their decision to purchase or not to purchase organic food online. Based on the assumption that consumers with higher level of education tend to have higher income, greater purchasing power, stronger awareness of health benefits and a higher tendency to use modern technologies and engage in online shopping, the following hypothesis are proposed:

H1: There is a significant and positive relationship between level of education and organic food purchase.

H2: There is a significant and positive relationship between household income level and organic food purchase.

H3: There is a significant and positive relationship between level of education and online organic food purchase.

H4: There is a significant and positive relationship between household income level and online organic food purchase.

METHODOLOGY SECTION

The research is based on a questionnaire composed of several sections. In the first section, respondents were asked questions designed to obtain their socio-demographic profiles. The second section explored respondents purchasing habits, the frequency of purchasing organic food, as well as their reasons for and against such purchases. In addition, respondents were asked to evaluate the diversity and quality of organic food available to them. The third section referred exclusively to online purchasing channels, with clarification that these included purchases made via web shops, social networks and messaging applications such as Viber and WhatsApp.

The questionnaire was developed based on previous research conducted on the same or similar topics [21], [22]. The survey was carried out from July 2024 to February 2025. It was distributed online and completed by 421 respondents. All questions were close-ended, allowing one or multiple responses. To successfully complete the questionnaire, respondents were required to answer all questions, therefore no missing responses were recorded in the dataset.

The data were analyzed using inferential statistical methods and conclusions were drawn through synthesis. From the total number of the respondents, those who answered that they do not reside in the Republic of Srpska were excluded. Consequently, the final sample consisted of 358 respondents residing in the Republic of Srpska.

The sample was obtained using non-probability and voluntary response sampling because the questionnaire was distributed online through social networks and emails. Therefore, the respondents were self-selected and no preselection or quota system was applied prior the survey, except for filtering respondents based on their place of residence. The structure of the sample, in terms of socio-demographic characteristics, may not fully correspond to the population structure of the Republic of Srpska.

The reliability of the sample was tested using Cronbach's alpha coefficient $\alpha = 0,203$. Descriptive statistics were applied to analyses the socio-demographic characteristics of the sample (Table 1). The results indicated that the gender distribution was not uniform (most respondents were female), exhibiting significant negative skewness and a flattened distribution, with women representing 72,3% of the sample and men 27,7%.

Level of education showed moderate negative skewness and slightly increased kurtosis, indicating that larger number of respondents held middle and higher education degrees, with a concentration of responses around the central values. The level of education was measured according to the degree of formal education (no formal education - NFE, primary school - PRI, secondary school- SEC, higher or university degree - UNI).

Household size demonstrated moderate negative skewness and high kurtosis, suggesting that respondents generally lived in larger households with three or four members, but none of the household categories was dominant.

The income variable was formulated to capture the total household income, from all household members: salaries, scholarships, pensions, rents, agricultural income and all other sources. The respondents selected the income group to which their household belonged. The results revealed moderate negative skewness and flattened distribution, indicating that most respondents belonged to higher income categories, although the respondents were widely distributed.

The age variable showed an almost symmetric distribution with significant kurtosis, suggesting an even distribution of ages among respondents. The average age was approximately 30 years, with standard deviation of $\sigma = 1.061$, indicating moderate dispersion around the mean.

The employments/work status variable showed an almost symmetric and normal distribution, implying no significant deviations and no dominant response category. Work status was categorized into five categories: students – STU, unemployed – UNE, employees

Galić, J. (2025). The impact of economic and educational status on organic food purchasing: a focus on online consumers. *STED Journal*, 7(2), 42-49.

in private sector – PRI, employed in public sector – PUB, retired – RET.

Based on the frequency of organic food consumption, the respondents were segmented into three groups:

- respondents who reported consuming organic food,
- respondents who purchase organic food occasionally and

➤ respondents who reported they do not purchase organic food.

Each group is consisted of distinct respondents and the hypothesis were tested using the nonparametric Kruskal-Wallis test.

Table 1. Descriptive statistics

Table 1. Descriptive statistics												
Gender			Education level		Household members		Household income level (in BAM)		Age		Work status	
Number	Male	99	NFE	2	1	19	up 1.000	29	up 20	8	STU	9
			PRI	6	2	56	1.001-2.000	80	21-30	46	UNE	37
	Female	259	SEC	171	3	81	2.001-3.000	118	31-40	108	PRI	164
			UNI	179	4	136	3.001+	131	41-50	107	PUB	117
					5	66			51 +	89	RET	31
Total	358		358		358		358		358		358	
Percentage	Male	27,7%	NFE	0,6%	1	5,3%	up 1.000	8,1%	up 20	2,2%	STU	2,5%
			PRI	1,7%	2	15,6%	1.001-2.000	22,3%	21-30	12,8%	UNE	10,3%
	Female	72,3%	SEC	47,8%	3	22,6%	2.001-3.000	33,0%	31-40	30,2%	PRI	45,8%
			UNI	50,0%	4	38,0%	3.001+	36,6%	41-50	29,9%	PUB	32,7%
					5	18,0%			51 +	24,9%	RET	8,7%
Modus	1.72		3.47		3.49		6.98		3.62		3.35	
Median	2.00		3.50		4.00		7.00		4.00		3.00	
SD	.448		.563		1.120		.957		1.061		.871	
Var	.201		.317		1.253		.916		1.126		.759	
Skewness	-1.003		-.647		-.477		-.520		-.304		-.173	
Kurtosis	-.999		.522		-.560		-.777		-.699		.186	

The segmented sample was subject to correlation analysis for the socio-demographic parameters household income level and education level and with aim to test hypothesis H1 and H2.

In the next stage, a subsample of 308 respondents was extracted from the initial

sample of 358, consisting only of those who reported purchasing organic food regularly or occasionally. Respondents who stated that they did not purchase organic food were excluded from further analysis. The subsample was used to examine the frequency of purchasing organic food exclusively through online

Galić, J. (2025). The impact of economic and educational status on organic food purchasing: a focus on online consumers. *STED Journal*, 7(2), 42-49.

channels. Correlation analyses were again performed between respondents who reported purchasing organic food online and the socio-demographic variables household income level and education level. Hypothesis H3 and H4 were also tested using the nonparametric Kruskal-Wallis test.

RESULTS AND DISCUSSION

The main research question of this study is to identify the impact of economic and educational status on consumers decision to purchase organic food, especially the impact of household income and educational level on the decision to purchase organic food through all distribution channels and particularly through online channels.

The respondents were asked “Do you purchase organic food?” (Table 2) and 73 respondents (20,4%) answered positively, 235 respondents (656%) stated that they occasionally purchase organic food and 50 respondents (14%) reported that they never purchase organic food.

Table 2. Frequency of purchasing organic food in Republic of Srpska

Frequency	Number	Percentage
Yes	73	20,40%
Occasionally	235	65,60%
Never	50	14,00%
Total:	358	100,00%

First and second group together show that 308 respondents (86%) of all the sample purchase or occasionally purchase organic food, what is in the line with previous research conducted in Republic of Srpska (Galić, 2022), although there is a noticeable decrease in the share of regular consumers and an increase in

those who reported not purchasing organic food.

By applying the Kruskal-Wallis test, the relationship between the frequency of organic food purchase (as the dependent variable) and the socio-demographic parameters education level and household income was examined. The analysis revealed (Table 3) a positive and statistically significant relationship for the education level variable and a positive but statistically insignificant relationship for household income level. Therefore, the level of education has a positive and significant effect on the frequency of organic food purchases what is in the line with previous studies [23], [24], [2]. Individuals with a higher education levels tend to have greater knowledge and awareness regarding the importance of healthy eating as well as a stronger interest in maintaining a healthy lifestyle [25].

When analyzing the second variable, the results show that the household income level is not a significant factor influencing the frequency of organic food purchases. This finding is not in the line with previous studies [23], [24], [26], [27], which identified a positive relationship between income level and organic food consumption, explaining that consumers with the higher income level have greater purchasing power and are more willing to pay higher prices for organic products, which are generally more expensive than conventionally produced alternatives.

The results confirm Hypothesis H1 and reject Hypothesis H2:

H1: There is a significant and positive relationship between level of education and organic food purchase – is confirmed.

H2: There is a significant and positive relationship between household income level and organic food purchase – is rejected.

Table 3. Differences in the frequency of organic food purchase

Results of Kruskal - Wallis test	
Variable	Do you purchase organic food?
Education level	χ^2 (df=3, n=358) =8,116; p=0,044
Household income level	χ^2 (df=3, n=358) =5,574; p=0,134

Galić, J. (2025). The impact of economic and educational status on organic food purchasing: a focus on online consumers. *STED Journal*, 7(2), 42-49.

When the same technique was applied to the subsample of respondents who regularly or occasionally purchase organic food (n=308), with the dependent variable being question “Have you purchased organic food online?” and the same socio-demographic parameters

(education level and household income), the results showed that none of the parameters was statistically significant (Table 4). However, the variable education level had a p-value of 0.090, suggesting a mild trend that could potentially reach statistical significance in a larger sample.

Table 4. Differences in the frequency of online organic food purchase

Results of Kruskal - Wallis test	
Variable	Do you purchase organic food online?
Education level	χ^2 (df=3, n=308) =6.491; p=0,090
Household income level	χ^2 (df=3, n=308) =0.310; p=0,958

These results indicate that, within the observed sample, both education level and household income do not significantly affect the frequency of purchasing organic food through online channels, leading to rejection of Hypothesis H3 and Hypothesis H4:

H3: There is a significant and positive relationship between level of education and online organic food purchase – is rejected.

H4: There is a significant and positive relationship between household income level and online organic food purchase – is rejected.

Comparable but opposite results were obtained in a 2020 study conducted in Republic of Serbia [17], where both parameters showed positive and significant effects on online organic food purchasing. Similarly, studies from Italy [28] and Czech Republic [29] found that education level influences consumers decisions to buy organic food online, as higher-educated consumers exhibit greater awareness and interest in healthy lifestyles [25]. Furthermore, online organic food buyers in Poland [30], Italy [28] and Czech Republic [29] were predominantly from higher income groups.

Given the discrepancy between these findings and previous studies, the reasons for the observed results may lie in the specific characteristics of the local market, the overall availability of online organic food stores or the limited size of the examined sample.

CONCLUSION

The findings of this study indicate that consumers education level has a statistically

significant impact on the frequency of purchasing organic food, while economic status measured by total household income, does not show a significant relationship. The hypothesis that higher education increases the likelihood of purchasing organic products was confirmed, aligning with prior regional studies. In contrast, the results are opposite from earlier research that identified income as a key determinant of such consumer behavior.

When focusing especially on online distribution channels of organic food, the results show that neither education level nor household income level has statistically significant effect. Considering the relatively small sample of online buyers what is a key limitation of this study, attention should be given to the mild trend observed for the education level variable that has could reach significance in a larger sample.

Further and more extensive research is therefore necessary to validate or challenge these findings. Future studies could also incorporate a wider set of variables to construct a more detailed profile of online organic food consumers.

This research contributes to a better understanding of the behavior of organic food consumers, particularly online shoppers. In an era where more individuals are choosing healthy and sustainable products, identifying the factors that encourage or limit such purchases have very high importance.

The findings of this research may be valuable to organic food producers, retailers or other stakeholders involved in the organic food

Galić, J. (2025). The impact of economic and educational status on organic food purchasing: a focus on online consumers. *STED Journal*, 7(2), 42-49.

market of the Republic of Srpska. The scientific contribution of this research lies in the fact that it represents the first analysis of this kind conducted in the observed territory, forming a basis for the future studies both regionally and internationally.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURE

1. Yussefi-Menzler, M. (2008). *The World of Organic Agriculture: Statistics and Emerging Trends 2008* (H. Willer, & N. Sorensen, Eds.) (1st ed.). Routledge. <https://doi.org/10.4324/9781849775991>
2. Đokić, N., & Milićević, N. (2016). Profil potrošača i prepreke za povećanje potrošnje organske hrane u Srbiji. *Anali Ekonomskog Fakulteta u Subotici*, 52(36), 65–77.
3. Galić, J. (2022). Socio-demographic profile of organic food consumers in the Republic of Srpska. *Anali Ekonomskog Fakulteta u Subotici*, 58(48), 3–14. <https://doi.org/10.5937/anebsub2248003g>
4. Radojević, V., Tomaš Simin, M., Glavaš Trbić, D., & Milić, D. (2021). A profile of organic food consumers—serbia case-study. *Sustainability (Switzerland)*, 13(1), 1–22. <https://doi.org/10.3390/su13010131>
5. Dangi, N., Gupta, S. K., & Narula, S. A. (2020). Consumer buying behaviour and purchase intention of organic food: a conceptual framework. *Management of Environmental Quality: An International Journal*, 31(6), 1515-1530. <https://doi.org/10.1108/MEQ-01-2020-0014>
6. Sudarević, T., & Radojević, V. (2018). Potrošački stavovi u kupovini organskih prehrambenih proizvoda. *Agroekonomika*, 47(80), 53–63. <https://www.agroekonomika.rs/index.php/arhiva>
7. Čolović, M., & Mitić, V. (2021). Determinant factors influencing organic foods purchase. *Acta Agriculturae Serbica*, 26(51), 89–95. <https://doi.org/10.5937/aaser2151089c>
8. Jarczok-Guzy, M. (2018). Obstacles to the development of the organic food market in Poland and the possible directions of growth. *Food Science and Nutrition*, 6(6), 1462–1472. <https://doi.org/10.1002/fsn3.704>
9. Kushwah, S., Dhir, A., Sagar, M., & Gupta, B. (2019). Determinants of organic food consumption. A systematic literature review on motives and barriers. *Appetite*, 143, 104402. <https://doi.org/10.1016/j.appet.2019.104402>
10. Nandi, R., Bokelmann, W., Gowdru, N. V., & Dias, G. (2017). Factors Influencing Consumers' Willingness to Pay for Organic Fruits and Vegetables: Empirical Evidence from a Consumer Survey in India. *Journal of Food Products Marketing*, 23(4), 430–451. <https://doi.org/10.1080/10454446.2015.1048018>
11. Rosário, A., & Raimundo, R. (2021). Consumer marketing strategy and e-commerce in the last decade: A literature review. *Journal of Theoretical and Applied Electronic Commerce Research*, 16(7), 3003–3024. <https://doi.org/10.3390/jtaer16070164>
12. Yanti, R., & David, W. (2024). The consumer purchase motivation of Organic Food in Online Retail. *Asia Pacific Journal of Sustainable Agriculture, Food and Energy*, 12(1), 21-27. <https://doi.org/10.36782/apjsafe.v12i1.333>
13. Gottumukkala, M. (2023). Digital Marketing Strategies of Organic Food Products with Special reference to Agricultural Sector. *Anvesak*, 51(2), 161-165.
14. Roy, P., & Datta, Dr. D. (2022). Impact of COVID-19 on Consumer Buying Behavior Towards Online and Offline Shopping. *SSRN Electronic Journal*, 9(6), 678–686. <https://doi.org/10.2139/ssrn.4205473>
15. Vučenović, S. R., Nuševa, D. P., Marić, D. S., Marić, R. M., Vukmirović, G. M., & Leković, K. P. (2021). Food Products Placement During Covid-19 Pandemic. *Food and Feed Research*, 48(2), 141–153. <https://doi.org/10.5937/ffr48-34389>

Galić, J. (2025). The impact of economic and educational status on organic food purchasing: a focus on online consumers. *STED Journal*, 7(2), 42-49.

16. Končar, J., Vučenović, S., & Marić, R. (2021). Challenges and Opportunities of Electronic Commerce in the Context of Global Pandemics. *International Scientific Conference Strategic Management and Decision Support Systems in Strategic Management*, 194-201.
https://doi.org/10.46541/978-86-7233-397-8_169
17. Čirić, M., Ilić, D., Ignjatijević, S., & Brkanlić, S. (2020). Consumer behaviour in online shopping organic food during the Covid-19 pandemic in Serbia. *Food and Feed Research*, 47(2), 149–158.
<https://doi.org/10.5937/ffr47-28815>
18. Stoica, M., Mehedintu, M., Stoian, M., Stancu, A., Filip, A., & Rosca, M. I. (2020). The Organic Food Market in Romania. *Journal of Emerging Trends in Marketing and Management*, 1(1), 280–288.
<https://doi.org/10.5593/sgemsocial2015/b23/s7.079>
19. Peštek, A., & Hadžijamaković, N. (2024). Customer attitudes towards e-commerce: case of Bosnia and Herzegovina. *CroDiM International Journal of Marketing Science Međunarodni Znanstveno-Stručni Časopis*, 7(1), 13–24.
20. Galić, J., & Sredić, D. (2025). The Values and Attitudes as a driver of organic Food Purchase. In D. Kojić and D. Sredić (Eds.), *XIV International confernece on social and technological development – STED 2025* (pp. 339-347). Trebinje: University PIM Banja Luka.
21. Scuderi, A., Bellia, C., Foti, V. T., Sturiale, L., & Timpanaro, G. (2019). Evaluation of consumers' purchasing process for organic food products. *AIMS Agriculture and Food*, 4(2), 251–265.
<https://doi.org/10.3934/agrfood.2019.2.25>
22. Wang, O., Somogy, S., & Charlebois, S. (2020). Food choice in the e-commerce era: A comparison between Business-To-Consumer (B2C), Online-To-Offline (O2O) and New Retail. *British Food Journal*, 122(4), 1215–1237.
23. Čolović, M., & Mitić, V. (2023). Individual customers characteristics and types of organic food. *Acta Agriculturae Serbica*, 28(56), 97–106.
<https://doi.org/10.5937/aaser2356097c>
24. Dimitri, C., & Dettmann, R. L. (2012). Organic food consumers: What do we really know about them? *British Food Journal*, 114(8), 1157–1183.
<https://doi.org/10.1108/00070701211252101>
25. Jakubowska, D., Grzywińska-Rapca, M., & Grzybowska-Brzezińska, M. (2025). Why Do Consumers Buy Organic? Exploring Motivations and Socio-Economic Patterns. *Agriculture* 15(1), 50.
<https://doi.org/10.3390/agriculture15010050>
26. Grzywińska-Rapca, M., Grzybowska-Brzezińska, M., Jakubowska, D., & Banach, J. K. (2025). The Perception of Organic Food Characteristics and the Demographic and Social Profile of Consumers: A Study of the Polish Market. *Foods*, 14(2), 1–18.
<https://doi.org/10.3390/foods14020308>
27. Tepavčević, J., Blešić, I., Todorović, M., & Petković, T. (2025). Organic and functional food consumption: a sociodemographic perspective. *BizInfo Blace*, 16(1), 77–85. <https://doi.org/10.71159/bizinfo250009T>
28. Dominici, A., Boncinelli, F., Gerini, F., & Marone, E. (2021). Determinants of online food purchasing: The impact of socio-demographic and situational factors. *Journal of Retailing and Consumer Services*, 60, 102473.
<https://doi.org/10.1016/j.jretconser.2021.102473>
29. Zámková, M., Rojík, S., Prokop, M., Činčalová, S., & Stolin, R. (2022). Czech Consumers' Preference for Organic Products in Online Grocery Stores during the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health*, 19(20), 1–14.
<https://doi.org/10.3390/ijerph192013316>
30. Bryła, P. (2018). Organic food online shopping in Poland. *British Food Journal*, 120(5), 1015–1027.
<https://doi.org/10.1108/BFJ-09-2017-0517>

KOVAČEVIĆ PRED EVROPSKIM SUDOM ZA LJUDSKA PRAVA: PROCESNA FARSA I SUMNJIV PRESEDAN U ANTIDISKRIMINACIONOJ PRAKSI

Živorad Rašević¹, Sandra Pajić Šavija²

¹Univerzitet PIM, Pravni fakultet, despota Stefana Lazarevića bb, 78 000 Banja Luka, Bosna i Hercegovina, rasevic71@gmail.com

²Visoka škola za poslovnu ekonomiju i preduzetništvo Beograd, Mitropolita Petra 8, 11 000 Beograd, Srbija, sandra_pajic@yahoo.com

ORIGINAL SCIENTIFIC PAPER

ISSN 2637-2150

e-ISSN 2637-2614

DOI 10.63395/STEDJournal0702090S

UDC 341.645.5(4):341.231.14

COBISS.RS-ID 143560449

Received: 02 November 2025.

Revised: 07 November 2025.

Accepted: 14 November 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Corresponding Author: University PIM, Faculty of Law, despota Stefana Lazarevića, bb, 78 000 Banja Luka, Bosnia and Herzegovina, rasevic71@gmail.com



Copyright © 2024 Živorad Rašević i Sandra Pajić Šavija; published by UNIVERSITY PIM. This work licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.

Citation: Rašević, Ž. i Pajić Šavija, S. (2025). Kovačević pred Evropskim sudom za ljudska prava: procesna farsa i sumnjiv presedan u antidiskriminacionoj praksi. *STED Journal*, 7(2), 50-64.

SAŽETAK

U ovom radu se metodima pravne dogmatike i korišćenjem teorijskih saznanja procesnog i antidiskriminacionog prava objašnjava postupak i ocjenjuje argumentacija Evropskog suda za ljudska prava (ESLJP) u

predmetu broj 43651/22, Slaven Kovačević (aplikant) protiv Bosne i Hercegovine (BiH). U ovom predmetu, aplikant je prvo ostvario još jednu ekspresnu pobjedu u isticanju povrede opšte zabrane diskriminacije iz člana 1. Protokola 12 (P12) uz Evropsku konvenciju o ljudskim pravima i osnovnim slobodama (EK) u uživanju prava da glasa na izborima za kandidate po svom političkom uvjerenju na osnovu člana 3. P1. Međutim, poslije osporavanja ove pobjede doživio je neočekivan procesni poraz u postupku pred Velikim vijećem ESLJP, u kome je ocijenjeno da aplikant nije žrtva diskriminacije i da je čak zloupotrijebio pravo na aplikaciju. U radu se takođe ukazuje na eventualne implikacije konkretne presude na dalji razvoj P12 i antidiskriminacionog prava. Detaljan uvid u radnje i rezonovanje svih procesnih subjekata otkriva indicije o nesavjesnom korišćenju procesnih ovlašćenja strana u postupku i pristrasnosti procesnih subjekata, te o neuređenosti i nepoštovanju pravnog okvira zastupanja BiH pred ESLJP. Procesni poraz aplikanta pred Velikim vijećem ukazuje na odustajanje ESLJP od dosadašnjeg proaktivnog pristupa u primjeni P 12 i na suzdržanost od daljeg miješanja u probleme konsocijativnog uređenja BiH. Međutim, taj novi pristup ne priliči instituciji Savjeta Evrope, čija je misija, između ostalog, suzbijanje diskriminacije, a nedosljedna argumentacija izvjesno ne doprinosi konceptualnom razvoju antidiskriminacionog prava i obeshrabruje države da ratifikuju inače nedovoljno prihvaćeni P 12.

Gljučne riječi: opšta zabrana diskriminacije, biračko pravo, status žrtve, zloupotreba prava na aplikaciju.

UVOD

U Presudi od 25.06.2025. godine, u predmetu br. 43651/22 Slaven Kovačević (aplikant) protiv Bosne i Hercegovine (BiH) broj 43651/22, Veliko vijeće Evropskog suda za ljudska prava (ESLJP) je proglasilo nedopustivom aplikaciju na osnovu člana 35. st. 3 Evropske konvencije o ljudskim pravima i osnovnim slobodama (EK) zbog zloupotrebe prava na aplikaciju i nedostatka statusa žrtve u odnosu na opštu zabranu diskriminacije u uživanju aktivnih izbornih prava iz člana 1. Protokola broj 12 (P 12), u vezi sa članom 3. P1 uz EK [1]. Rezultat je stavljanje van snage prvostepene presude od 29.08.2023. godine čime je ovaj predmet pravosnažno okončan, a u kome je aplikant prošao dug put od još jedne ekspresne pobjede u napadu na notorne probleme etničkog i entitetskog predstavljanja u Parlamentarnoj skupštini i Predsjedništvu BiH, sve do procesnog poraza, koji je uslijedio poslije udruženog kontranapada države, Visokog predstavnika i Republike Hrvatske.

Navedeni predmet zaslužuje pažnju stručne i svake druge javnosti, iz više razloga. Prvo, Presuda Velikog vijeća je prekinula niz osuđujućih presuda protiv BiH u predmetima diskriminacije u uživanju biračkih prava, počev od Sejdić i Finci [2] i tako dovela u pitanje dosljednost evropskog nadzora ljudskih prava i usmjeravanja ustavnog razvoja BiH. Iako se radi o procesnoj presudi koja ne prejudicira nijedno materijalno pravno pitanje koje je bilo predmet ovog spora, ono što ipak pada u oči jeste promjena pristupa ESLJP u odnosu na raniju antidiskriminacionu praksu u sporovima sa BiH. Drugo, ovo su prvi predmeti u kojima je ESLJP dosudio povrede opšte zabrane diskriminacije iz P 12, tako da ova presuda može da se smatra presedanom u razvoju evropskog antidiskriminacionog prava uopšte. Na kraju, u javnosti su već iznesene ozbiljne zamjerke svim učesnicima u postupku, koje se svode na sumnje o nesavjesnom parničanju, pristrasnosti i skrivenim političkim motivima neprimjerenim u postupku pred ESLJP.

To svakako nalaže detaljnu pravnodogmatsku analizu cjelokupnog postupka, procesnih radnji stranaka i rezonovanja ESLJP u Presudi i poređenje sa teorijskim saznanjima i ranijom praksom po

P12. Zato se u naredna dva dijela opisuju i objašnjavaju tok prvostepenog i drugostepenog postupka pred ESLJP, procesne radnje stranaka i argumentacija u presudama, Zatim se sumiraju nalazi i ocjenjuju nalazi iz prethodna dva dijela, a na kraju analiziraju mogući uticaji predmeta na dalju afirmaciju P12 i razvoj antidiskriminacionog prava.

PRVOSTEPENI POSTUPAK I PRESUDA

U praksi ESLJP, sve do predmeta Kovačević, pozivanje na diskriminaciju u uživanju izbornog prava u BiH, bilo na osnovu člana 14. EK u vezi sa članom 3. P 1, bilo na osnovu člana 1. P 12, predstavljao je pouzdan recept za uspjeh. Naime, do sada je dosuđeno ukupno sedam ovakvih povreda opšte zabrane diskriminacije u vezi sa izbornim pravima, počev od već pomenutog predmeta Sejdić i Finci [2], preko Zornić [3], Šlaku [4], Pilav [5], Baralija [6], Pudarić [7], do prvostepene presude u predmetu Kovačević. Razlozi za uspjehe aplikanta mogu se pronaći, koliko u nesavršenostima domaćeg ustavnog i izbornog sistema, toliko i u blagonaklonom pristupu ESLJP. Naime, u dosadašnjoj praksi ESLJP je redovno zaključivao da domaći pravni lijekovi u ovim stvarima nisu djelotvorni i tako ostavio širom otvorena vrata za aplikacije ove vrste, a u meritornom odlučivanju je često konsultovao veliki broj kritičara ustavnog i izbornog sistema u BiH i proponenata njihove reforme, od specijalizovanih institucija Savjeta Evrope (SE), do nevladinih organizacija. Smatramo da je upravo iz navedenih razloga, početni uspjeh aplikanta u ovom predmetu sasvim razumljiv, bez obzira na razlike u isticanju nešto drugačijeg povezanog subjektivnog prava (povreda aktivnog umjesto pasivnog biračkog prava) i osnova diskriminacije, koji je ostao nepotpuno razjašnjen.

U postupku pred Četvrtim odjeljenjem ESLJP aplikant je iznio sljedeće navode: živi u Sarajevu, po struci je politolog, zaposlen kao politički savjetnik člana Predsjedništva BiH, a izostalo je izjašnjavanje po nacionalnom osnovu. Razlog njegovog obraćanja ESLJP je ograničenje aktivnog biračkog prava na izborima 2022. godine, koje se sastojalo u nemogućnosti da glasa za kandidate za Dom naroda Parlamentarne skupštine BiH (DNPS

BiH) i Predsjedništvo BiH koji bi odgovarali njegovom političkom uvjerenju. Nemogućnost se sastojala u dobro poznatoj kombinaciji teritorijalnih i etničkih zahtjeva iz članova IV i V Ustava BiH (1995), koji se odnose na pravo kandidovanja, tj. pasivno biračko pravo isključivo za lica koja pripadaju određenom konstitutivnom narodu i entitetu. Aplikant je smatrao da kandidati koji najbolje predstavljaju njegove politička uvjerenja o nerelevantnosti etničke pripadnosti nisu iz odgovarajućeg entiteta i/ili odgovarajuće etničke pripadnosti i da je zbog ove nepovoljnosti diskriminisan. Istakao je povrede izbornog prava iz člana 3. P 1 (Pravo na slobodne izbore), prava na djelotvoran pravni lijek iz člana 13. EK i zloupotrebe prava iz člana 17. EK, te člana 14. EK (Zabrana diskriminacije) u vezi sa članom 3. P 1 i člana 1. P 12 (Opšta zabrana diskriminacije).

Zastupnik BiH je, kao i ranijim predmetima, prigovorila da aplikant nije iskoristio domaće pravne lijekove, jer je prije svega propustio da podnese prigovor Centralnoj izbornoj komisiji BiH, zatim žalbu Sudu BiH i konačno apelaciju Ustavnom sudu BiH (US BiH). Međutim, sud je u stavovima 29. do 33. razmotrio i odbio ovaj prigovor BiH, lakonskim pozivanjem na relevantne principe iz predmeta Vučković i dr. protiv Srbije [8]. Time je prihvatio kontraargumente aplikanta o nedjelotvornosti tih pravnih lijekova, što je već utvrđeno u ranijim presudama koji su se odnosili na nemogućnost kandidovanja na izborima (aktivno biračko pravo). Kao i u prethodnim predmetima, u kojima je omogućen ekspresan pristup ESLJP, ovakvo rezonovanje se ne čini ubjedljivim, posebno iz razloga da iz predmeta Vučković, na koji se poziva ESLJP, proizlazi da je aplikant imao na raspolaganju još dva pravna lijeka, a to su parnične tužbe zbog povrede prava ličnosti iz članova 157. i 199–203. Zakona o obligacionim odnosima (ZOO) [9] i za zaštitu od diskriminacije iz Zakona o zabrani diskriminacije (ZZD) [10]. Ovi pravni lijekovi do sada nisu bili isticani u prigovorima države i ne mogu se *a priori* smatrati nedjelotvornim, jer se njima može postići isto ono što su aplikanti ranije postizali pred ESLJP, a to je puka deklaracija o povredi

ljudskog prava [11, str. 79] i eventualno naknada štete. Ovi neistaknuti pravni lijekovi omogućuju i više, tj. prestanak povrede prava ličnosti iz člana 157. ZOO ili zabrana budućih diskriminirajućih radnji iz člana 12. st.1.b. ZZD. Ignorisanje ovih domaćih pravnih lijekova svakako ide na teret zastupniku države, a možda i postupajućem BiH sudiji Vehaboviću, kome su ovi pravni lijekovi svakako poznati kao autoru prvog komentara ZZD [12]. Osim toga, dotadašnja nedjelotvornost pravnih lijekova pred US BiH u pogledu pasivnog biračkog prava nije se mogla bez valjanog obrazloženja primijeniti i na aktivno biračko pravo, a praksa u tom pogledu ne postoji. Prema stanovištu iz stava 74. Presude Vučković „postojanje pukih sumnji u izglede na uspjeh konkretnog pravnog lijeka koji nije očigledno uzaludan nije valjan razlog da se ne iskoristi taj put postizanja zadovoljenja.“ Sve ovo ukazuje na, u najmanju ruku, indolentnost zastupnika države u prigravaraju o domaćim pravnim lijekovima i propust suda da primijeni pravo koje zna (*iura novit curia*).

U ispitivanju dopuštenosti aplikacije, Sud je po službenoj dužnosti u stavu 39. zaključio da je stvarno nadležan da primijeni opštu zabranu diskriminacije, zaključujući da se aplikant poziva na pravo određeno domaćim zakonom iz člana 1 P 12, a da to uključuje i pravo koje proizlazi iz jasne obaveze ili diskrecionog ovlašćenja javne vlasti u smislu autentičnog tumačenja P12 [13, stav 22]. Međutim, kao i u ranijim dosuđenim povredama P 12, nije jasno naveo kojim odredbama domaćeg pozitivnog prava je određeno to subjektivno pravo aplikanta da bez etničkog i entitetskog ograničenja glasa za Dom naroda PS BiH i Predsjedništvo BiH, odnosno obaveza ili diskreciono ovlašćenje javne vlasti koje bi ukazalo na važenje jednog takvog subjektivnog prava. Naprotiv, prije bi se moglo zaključiti da takvo neograničeno pravo glasa uopšte nije predviđeno domaćim pravom. Drugim riječima, sistemsko tumačenje odredbi Izbornog zakona (IZ) [14], članova IV i V Ustava BiH i člana 3. P 1, upućuje da subjektivno pravo aplikanta, odnosno obaveza javne vlasti na neograničeno aktivno biračko pravo, ne važi u odnosu na Dom naroda PSBiH i Predsjedništvo BiH.

Takođe, po službenoj dužnosti, Sud je u stavovima 40–42. ispitao dopuštenost aplikacije u pogledu statusa žrtve aplikanta i zaključio da se u ovom predmetu ne radi o *actio popularis*, tj. da je aplikant direktno pogođen spornom mjerom diskriminacije u vršenju aktivnog biračkog prava, zbog same činjenice da mu je ograničeno pravo glasa.

U meritumu, sasvim ispravno je zaključeno da se ne razmatra istaknuta povreda člana 14. EK, jer je opšta zabrana diskriminacije iz člana 1 P 12 širi pojam koji u cjelosti obuhvata zabranu diskriminacije iz člana 14. Drugim riječima, svaka povreda zabrane diskriminacije je ujedno i povreda opšte zabrane diskriminacije [15, str. 38–39], ali ne i obrnuto: zato je iz razloga procesne ekonomije dovoljno ispitati navode o povredi opšte zabrane diskriminacije.

Međutim, argumentacija o pravnoj kvalifikaciji diskriminacije ne izgleda tako ubjedljivo. Prvo, kao komparator, tj. subjekt koji je tretiran povoljnije u odnosu na aplikanta, uzeta su „lica iz FBiH koja se izjašnjavaju kao Bošnjaci i Hrvati, i lice iz RS koje se izjašnjava kao Srbin.“ Slabost ovog komparatora je očigledna, jer i ta lica koja se etnički izjašnjavaju mogu da imaju politička opredjeljenja istovjetna aplikantovim, pa bi podjednako bili osujećeni da glasaju za kandidate koji se ne izjašnjavaju etnički ili ne žive u istom entitetu. Dalje, analogija sa predmetom Sejdić i Finci u stavu 51. se čini nategnutom, jer se u predmetu Kovačević ne radi o rasnoj diskriminaciji kao „posebno strahovitoj vrsti diskriminacije“ prema licima romske i jevrejske etničke grupe, nego prema licu čija je etnička pripadnost u trenutku odlučivanja bila nepoznata. Kao dodatni argument o nelegitimnosti izbornih aranžmana, u stavovima 57. i 59. sud se poziva na mišljenje institucija SE i na raniji stav suda iz predmeta Zorić „da je došlo vrijeme za politički sistem koji će omogućiti svakom građaninu BiH da se kandiduje na izborima za Predsjedništvo i Dom naroda BiH...“ Međutim, u ovom predmetu se nije radilo o kandidovanju nego o biranju, pa je primjena ovakve analogije trebalo da bude jasnije obrazložena. Ipak, ako je takva analogija i moguća, ESLJP je trebalo da prihvati i pozivanje zastupnika države na

predmet Mathieu-Mohin i Clerfayt protiv Belgije [16], u kome je odbijena istaknuta povreda aktivnog biračkog prava zbog obaveze kandidata da se izjasne na kom će jeziku položiti zakletvu – francuskom ili flamanskom. Da bi odbio ovu odbranu države, Sud se poslužio rezonovanjem US BiH u istom predmetu, u kome je zaključio da je „situacija ispitana u ovom predmetu značajno drugačija od domaćeg izbornog sistema utemeljenog na konceptu konstitutivnih naroda.“ Ovdje ne treba da promaknu tri ozbiljne kontradiktornosti. Prvo, stanovište o neprimjenjivosti analogije sa belgijskim modelom se teško može opravdati, jer je dobro poznato da je upravo belgijsko konsocijativno uređenje najbliže domaćem. Drugo, tumačenja US BiH ni na koji način ne mogu da budu obavezujuća za ESLJP. Takođe, i treće stanovište da je izjašnjavanje o jeziku „znatno drugačije“ od izjašnjavanja o nacionalnoj pripadnosti izgleda neutemeljeno, jer je jezik takođe jedno od ključnih obilježja nacionalnog identiteta.

Bilo kako bilo, ESLJP je na kraju odbacio pritužbe aplikanta o samostalnoj povredi prava na izbore iz člana 3. P 1 zbog neispunjenosti domaćih pravnih lijekova, prava na djelotvoran pravni lijek iz člana 13. EK i zloupotrebe prava iz člana 17. zbog očigledne neosnovanosti, i dosudio povredu opšte zabrane diskriminacije iz člana 1. P 12 u odnosu na glasanje za Dom naroda PS BiH i Predsjedništvo BiH. Snažne argumente za osporavanje prvostepene presude je obezbijedila predsjednik postupajućeg Četvrtog odjeljenja, sudija Kucsko – Staudlmayer, koja je jedina glasala protiv. U izdvojenom mišljenju, ona je kritikovala opravdavanje neiskorišćenosti domaćih pravnih lijekova zbog njihove navodne nedjelotvornosti „kao generalizovanu konstataciju,“ a zbog činjenice da aplikant nije pružio nijedan dokaz u tom smislu. U pogledu aplikantovog statusa žrtve, nije prihvatila njegove navode kao nejasne i apstraktne, a nije se složila ni sa izjednačavanjem aktivnog i pasivnog biračkog prava jer se time „insinuira koncept bez presedana u kojem svaki birač ima individualno pravo na kandidate koji ga predstavljaju“, a to se, po njenom mišljenju, ne može garantovati ni u jednoj predstavničkoj

demokratiji. Izrazila je i sumnju u odnosu na aplikantove navode da na izborima nije mogao glasati za člana Predsjedništva BiH, i upitala da li je taj član Predsjedništva čiji je aplikant savjetnik u stvari mogao biti njegov izbor. Na kraju je izrazila uvjerenje da rješenja za političku disfunkcionalnost treba tražiti unutar BiH i da se odluke Ustavnog suda BiH ne mogu olako smatrati nedjelotvornim pravnim lijekom.

POSTUPAK PRED VELIKIM VIJEĆEM ESLJP I PRESUDA

U literaturi se često kao najveći problem antidiskriminacionog prava navodi kontroverznost i apstraktnost normativnih pojmova, što u konkretnim predmetima rezultira arbitrarnim odlukama [17, str. 422]. Zato nije bilo teško pronaći razloge za osporavanje presude, iako vlasti BiH do sada nisu objasnile zašto je bilo važno da se to učini. Bilo kako bilo, argumenti za procesni poraz aplikanta su već bili artikulisani u izdvojenom mišljenju sudije Kucsko – Stadlmayer. Na zahtjev BiH, koji se sastojao u procesnim prigovorima o neprihvatljivosti aplikacije zbog zloupotrebe prava na njeno podnošenje i nedostatka statusa žrtve iz člana 35. st 3 EK, predmet je upućen Velikom vijeću 14.12.2023. godine. Obje strane su zahtijevale izuzeće sudija na osnovu člana 28. st. 2 Poslovnika ESLJP [18], upotrebom neuobičajeno teških i diskreditujućih zamjerki i insinuacija. Aplikant je tvrdio da je predsjedavajuća Kolegijuma Velikog vijeća, sudija O’Leary, omogućila da se zahtjev BiH uzme u postupanje, iako je znala da zastupnici BiH, koji su podnijeli zahtjev nisu imali ovlaštenje za to, da je krila tu činjenicu od drugih članova Kolegijuma i vršila pritisak na njih, te da se često sastajala sa predstavnicima Republike Hrvatske, a sve u cilju stavljanja prvostepene presude van snage. Sa druge strane, zastupnik BiH je tvrdio da domaći sudija Vehabović nije bio nezavisan i nepristrasan u prvostepenom postupku. Oba zahtjeva su odbijena prethodnim procesnim odlukama i obrazložena u stavovima 9. i 10. presude. U sporu je dozvoljena intervencija Republike Hrvatske i Visokog predstavnika u BiH (OHR) na osnovu članova 36. EK i 44. Poslovnika ESLJP. Intervencija OHR pred

ESLJP je još jedan od presedana, imajući u vidu da to nije činjeno ranije i da se njegov pravni subjektivitet teško može da odvoji od pravnog subjektiviteta BiH. Javna rasprava je održana 20.11.2024. godine [19].

U Presudi Velikog vijeća prvo je u stavovima 78–107. odlučeno o aplikantovom prigovoru nedostatka aktivne procesne legitimacije na strani države, koji je izazvao otvorene sukobe u tumačenju nadležnosti između nosilaca najviše vlasti u BiH. Naime, aplikant je prigovarao da je zastupniku države, koje imenuje Savjet ministara BiH (SM BiH), po unutrašnjim propisima prestao mandat još prije dvije godine. Po njemu, ovi „takozvani vršioci dužnosti zastupnika“ uopšte nisu imali ovlaštenje da ospore prvostepenu presudu ESLJP, bez odobrenja svog vlastodavca, odnosno Ministra za ljudska prava i izbjeglice BiH. Kada je u toku postupka zastupnica Mijić izdejstvovala ovlaštenje od Predsjedavajuće SM BiH, prigovorio je da ovo neblagovremeno ovlašćivanje nije zakonito, iz razloga što je imenovana po četvrti put, iako je zakonsko ograničenje na maksimalno tri tromjesečna perioda. Prigovarao je i kada je četvrti tromjesečni mandat zastupnice Mijić istekao u toku postupka. Upravo zbog ovih procesnih nedostataka, aplikant je tražio da Veliko vijeće odbaci zahtjev države kao nedopušten. Argumente aplikanta da su zastupnici BiH pred ESLJP u ovom predmetu djelovali *ultra vires* podržao je svojim podneskom Ministar odbrane BiH i Zamjenik Predsjedavajuće SM, koji se očigledno lažno predstavio kao „ko-predsjedavajući SM“ („co-Chair“), tvrdeći da zastupnik države nije ovlašten da podnese zahtjev bez kolektivne odluke SM. To je učinio i član Predsjedništva BiH Komšić, argumentujući da ne postoji odluka SM o podnošenju zahtjeva i potvrđivanju statusa zakonitosti vršioca dužnosti zastupnika. Sa druge strane, tzv. vršilac dužnosti zastupnika nije negirala da joj je mandat po unutrašnjim propisima istekao, ali je smatrala da je njena procesna legitimacija ipak opstala, jer poslije isteka njenog tromjesečnog imenovanja nisu imenovani drugi zastupnici. Po njoj, bila je ovlaštena i nadležna da samostalno podnese zahtjev Velikom vijeću i u ovako problematičnom mandatu, pogotovo što to SM

to nije osporio. U tu svrhu priloženo je i pismo Predsjedavajuće SM, koja je podržala njenu argumentaciju tvrdeći da je ona jedina nadležna za imenovanje zastupnika. Poslije detaljne analize argumenata obje strane, Veliko vijeće je odbilo prigovore aplikanta, rezonujući da, ni SM, niti drugi nadležni organi, nisu odlučili o povlačenju zahtjeva, a da „bilo koja procesna neregularnost oko statusa vršioca dužnosti zastupnika prema domaćem pravu ostaje unutrašnja stvar, koja treba da bude riješena u domaćem pravnom sistemu.“ Ovo opredjeljenje Velikog vijeća za argumente države je utemeljeno u prethodnoj praksi ESLJP o nemiješanju u unutrašnja pitanja države, u koja spada i zastupanje. Međutim, iz sasvim neprimjerene korespondencije institucija BiH sa ESLJP moglo se pronaći više nego dovoljno razloga da se država i njen zastupnik kazne za procesnu nedisciplinu i nepoštovanje suda. Ovo pogotovo što su prezentovana konfuzija i ozbiljni nedostaci u domaćem pravnom okviru zastupanja pred ESLJP mogli da umanje procesne izgleda aplikanta da odbrani prvostepenu presudu.

Iako se to nije desilo, ESLJP od domaćih vlasti sigurno očekuje da se pozabavi ovim nedostacima, tj. da utvrdi ko je vlastodavac zahtjeva za upućivanje predmeta na Veliko vijeće, šta to piše u prvostepenoj presudi zbog čega je bilo neophodno da se ospori, i da li je zastupnik države djelovao *ultra vires*. U vezi sa ovim poslednjim, posebno čudi da su SM BiH i tzv. vršilac dužnosti zastupnika, potpuno ignorisali Zakon o Pravobranilaštvu BiH (ZPBiH) [20], u čijem se članu 13. stav 5. određuje nadležnost zastupanja BiH od strane ove institucije pred međunarodnim sudovima. To budi sumnje na kršenje ovog zakona, jer je upravo ova institucija trebalo da obezbijedi kontinuitet zakonitog zastupanja države, a ne da se pribjegava *ad hoc* improvizacijama SM u podzakonskim aktima kojima se ograničava ovlašćenje na tri tromjesečna perioda i pozivanju na vršenje dužnosti po isteku. Bilo kako bilo, na vlastima BiH je da djeluju odgovorno i preduzmu mjere da se zakonom uredi zastupanje pred ESLJP da bi se isključilo štetno politikantstvo i pogodovanje partijskim, etničkim i drugim partikularnim interesima.

Dalje, u stavovima 114. do 118. Veliko vijeće je odlučilo da prvostepenu presudu ispituje samo u dijelu u kome je proglašena prihvatljivom u toj presudi i da odbaci podneske aplikanta u kojima je ponovo istakao u prvostenom postupku već odbačeni navod o samostalnoj povredi prava na izbore iz člana 3. P 1. Iz tog razloga je odbacio i po prvi put istaknute pritužbe na notornu intervenciju OHR u izborni sistem na dan prije izbora 2022. godine. Intervenciju OHR u izborni sistem je svakako trebalo osporavati od početka kao tešku povredu vladavine prava u BiH koja je uticala na aplikanta, ali se odbacivanju ovih novoistaknutih navoda ima šta prigovoriti. Naime, ovdje se nije radilo o preinačenju aplikacije navodima koji ne pripadaju ovom predmetu, nego o preciziranju kojim se prije dopunjuje nego što mijenja već prezentovano činjenično stanje po pravnoj kvalifikaciji koju aplikant nije izmijenio. Nažalost, Veliko vijeće je na ovaj način izbjeglo da se izjasni kako o legitimnosti neblagovremenog i nedemokratskog nametanja izbornih pravila, tako i o spornoj legitimnosti njihovog donosioca, tj. OHR.

U stavovima 119. do 139. Veliko vijeće je ocijenjivalo procesni prigovor BiH o zloupotrebi prava na aplikaciju iz člana 35. stav 3. EK, koji je očigledno bio usmjeren na diskreditaciju aplikanta, odnosno da je obmanuo Sud netačnim prikazivanjem ustavne i političke strukture BiH; da je prekršio Pravilnik Suda i potkopao imidž nepristrasnosti i objektivnosti ESLJP objavljivanjem prvostepene presude u medijima dva dana prije njenog službenog publikovanja; da je u domaćoj javnosti BiH koristio svoj politički položaj da ospori status zastupnika države i prijetio im krivičnim gonjenjem; da je OHR nazvao simpatizerom nacista; da je namjerno skrivao od ESLJP svoje ranije etničko izjašnjavanje da bi obmanuo Sud, te da je u tom cilju uklonio tragove tog izjašnjavanja kao odbornika Gradskog vijeća Sarajeva; da svrha njegove aplikacije nije zaštita povrijeđenog prava, „nego zloupotreba prava na aplikaciju da bi se ostvarili politički ciljevi partije kroz Sud, umjesto političkim sredstvima u političkoj areni.“ Ovo je podržala i zastupnica intervenijenta-Republike Hrvatske, dokazujući

da aplikant posjeduje hrvatsko državljanstvo na temelju izjašnjavanja o pripadnosti hrvatskom narodu. Aplikant je negirao namjeru zloupotrebe, tvrdeći da se nikada nije etnički izjašnjavao u izbornom procesu jer to smatra pogrešnim. U ocjeni iznesenih argumenata, ESLJP se najpre pozvao na raniju praksu o zloupotrebi prava na aplikaciju iz člana 35. stav 3. EK kao „izuzetne procesne mjere“ koja se shvata, u skladu sa opštom pravnom teorijom, kao škodljivo vršenje prava u svrhu suprotnoj od one zbog kojih je to pravo ustanovljeno. Zaključujući da je aplikant zloupotrijebio pravo na aplikaciju, Veliko vijeće je prihvatilo neke od gore iznesenih navoda države, a neke razloge je utvrdilo po službenoj dužnosti. U pojedinostima, Veliko vijeće smatra da je aplikant posegao za „klevetničkim i raznim izrazima“ u podnescima kojima je napadao i tražio izuzeće sudije i vrijeđao Predsjednika Suda, zlonamjerno optuživao zastupnike države i prijetio im krivičnim gonjenjem, i da je brisanjem podataka sa interneta o svom etničkom izjašnjavanju u toku postupka pokušao da obmane ESLJP.

Ovo je inače jedna od rijetkih odluka o odbacivanju zbog zloupotrebe prava na aplikaciju, a obično se donosi kada se aplikacija odbacuje iz još nekog razloga [21, str. 457]. Tako je bilo i u ovom slučaju, a taj drugi razlog je nedostatak statusa žrtve, koji je raspravljen i utvrđen u stavovima 140. do 217. Prigovor zastupnika države se sastojao u navodima da je aplikacija skup blanketnih i apstraktnih referenci o manama izbornog zakonodavstva u BiH iz kojih se ne vidi šta predstavlja diskriminaciju *in concreto*. Po njemu, u prvostepenoj presudi pogrešno shvaćene odredbe izbornog zakonodavstva u smislu da aplikant nije bio u mogućnosti da glasa za kandidata po svom izboru jer su na nivou entiteta u kome je konzumirao svoje pravo bili zastupljeni i kandidati koji uključuju širok spektar političkih opcija, uključujući i one koji su nezavisne od etničke pripadnosti. I prigovor zastupnice Hrvatske je išao u prilog BiH, a sastojao se u navodima da je aplikacija u stvari nedopuštena *actio popularis*. Pored toga, ponovila je i ono što je zastupnik BiH bezuspješno istakao u prvostepenom postupku: da je ESLJP već ranije u predmetu

Mathieu-Mohin i Clerfayt protiv Belgije dosudio da izvjesna etnička ograničenja u kandidovanju za jedan dom skupštine nisu protivna EK. Zastupnik OHR je negirao osnovanost izjednačavanja aktivnog i pasivnog biračkog prava i razlikovanja birača FBiH u izborima za Dom naroda PS BiH po etničkom kriterijumu, iz razloga što birači ne biraju direktno delegate za taj dom.

Aplikant se branio da je „žrtva političkog sistema“ zbog direktne izloženosti ustavnim i izbornim ograničenjima po teritorijalnom i etničkom osnovu, smatrajući da etnicitet ne smije da bude „odlučujući i isključujući faktor“ u vršenju i aktivnog i pasivnog biračkog prava, da takve restrikcije treba da se ukinu jer su ga spriječile da svoje izorno pravo slobodno uživa, da su ta ograničenja manja u entitetu u kom on ne uživa izorno pravo i da njegovo ranije etničko izjašnjavanje nije relevantno u ovom predmetu. Na traženje Suda, pojasnio je navod o diskriminaciji isticanjem komparatora, tj. lica koje se tretira povoljnije od njega, u vidu glasača iz Republike Srpske, a za osnov diskriminacije je odredio prebivalište.

Poslije opširnog razmatranja iznesene argumentacije, Veliko vijeće je prihvatilo argumentaciju BiH i interevenijenata da aplikantu nedostaje status žrtve, ne negirajući da je aplikantovo subjektivno pravo da bira delegate u Domu naroda PS BiH i Predsjedništvo BiH „moglo biti donekle pogođeno“ diskriminirajućom prirodom primjenjivih domaćih normi. Zaključeno je da aplikacija predstavlja „apstraktnu kritiku“ pozitivnog prava i stoga nedopuštenu *actio popularis*, zbog odsustva aplikantovog objašnjenja kako su te norme uticale na uživanje njegovog subjektivnog prava.

Kao i u prvostepenom postupku, odluka o odbacivanju aplikacije donesena je velikom većinom. Jedini protivnik bio je domaći sudija Vehabović, koji je priložio opširno izdvojeno mišljenje. U procesnim odlukama, on se nije složio sa stavom Velikog vijeća da zastupniku BiH nije bilo potrebno ovlašćenje nadležne vlasti u BiH za postupanje, ni da se OHR dozvoli da bude intervenijent, jer se radi o „surogatu državne vlasti“, a ne objektivnoj trećoj strani. Pored toga, smatrao je da je u odnosu na predmet Sejdić i Finci postavljen

viši prag dokazivanja statusa žrtve, jer je za dokazivanje tretmana aplikanta u uživanju aktivnog biračkog prava koji je nepovoljniji u odnosu na komparator bilo dovoljno za priznanje statusa žrtve. Smatra da je Presuda pretjerano formalistička, nedovoljno osjetljiva po pitanju strukturne prirode povrede prava aplikanta i politički oprezna na način koji urušava djelotvornost EK u suočavanju sa sistemskom diskriminacijom. Sve to, po njegovom mišljenju, može da se shvati kao poruka ESLJP da samo najotvoreniji i individualni oblici diskriminacije zaslužuju zaštitu, čime se potkopava ostvarivanje progresivnih ciljeva EK. Sudija Vehabović nije se složio ni sa stanovištima o razlikama između uživanja aktivnog i pasivnog biračkog prava, ni da aplikant nije bio direktno pogođen jer nije bilo nekog posebnog akta javne vlasti, smatrajući da se ovdje radi o prepreci ustanovljenoj samim zakonom. Takođe je iznio i široku argumentaciju o primjeni P 12, podsjećajući da član 2. ovog protokola zabranjuje javnim vlastima svaku diskriminaciju na osnovu pola, rase i etničke pripadnosti, zaključujući da bi svako ko je izložen diskriminirajućem tretmanu trebalo da se smatra žrtvom diskriminacije. Nije se složio ni sa zaključkom suda o zloupotrebi prava na aplikaciju, navodeći, između ostalog, da smatra da aplikantovi prigovori o nelegitimnosti zastupnika BiH nisu bili klevetnički nego čisto pravni. Sa druge strane, Vehabović je istakao da je ponašanje zastupnika države „problematično“, zato što je u postupku sugerisao da je aplikant mogao da otkloni svoj nepogodan tretman prijavom prebivališta u drugom entitetu, što bi predstavljalo kršenje zakona, i što je neprimjereno istraživao aplikantovo etničko porijeklo. Nije se složio ni sa stavom Velikog vijeća da je aplikantovo izražavanje sumnji u nepristrasnost Predsjednika ESLJP neprihvatljivo, jer se radi o pravnim argumentima u zahtjevu za izuzeće i da stoga ne zaslužuju procesnu kaznu.

OCJENA: ZAMJERKE, SUMNJE I POUKE

Kada se sumira sve gore izneseno, čini se da treba upozoriti stručnu i svaku drugu javnost na zabrinjavajuće aspekte ovog

predmeta, u kome se nisu sukobili samo argumenti države, intervenijenata i aplikanta. Ukratko, sporili su se svi procesni subjekti, često prelazeći granice obzira, i otkrivajući brojne kontroverze. Prvo, obje strane su argumentima *ad hominem* osporavale drugoj strani procesnu legitimaciju, i to aplikant prigovorom da je zastupanje države bilo nelegalno, a zastupnici države prigovorima o zloupotrebi prava na aplikaciju i nedostatku statusa žrtve. Drugo, nosioci najviših funkcija u BiH su se sporili o nadležnosti vlastodavca za zastupanje pred ESLJP, o legalnosti zastupanja i o potrebi da se prvostepena presuda uputi pred Veliko vijeće. Treće, aplikant je osporavao nepristrasnost predsjedavajuće Kolegijuma sudije O'Leary, Predsjednika ESLJP i intervenijenta OHR. Na kraju, zastupnik države je osporavao nepristrasnost domaćeg sudije Vehabovića i obrnuto – sudija Vehabović se nije složio sa odlukom većine o legitimnosti zastupanja države i o zloupotrebi aplikacije i nedostatku statusa žrtve.

Konačna presuda ipak izgleda kao logičan završetak sporenja aplikanta sa državom. Ne može se prigovarati odluci ESLJP da procesno kazni aplikanta zbog licemjerne mimikrije etabliranog etnički deklarisanog političara, koji se ESLJP predstavio kao obični građanin ostavljen na margini političkog života zbog etničkog neizjašnjavanja. Osim toga, aplikant nije imao valjano opravdanje za neiskorišćenost domaćih pravnih lijekova, jer je pred građanskim i US BiH mogao da traži zadovoljenje u parnicama zbog diskriminacije i povrede prava ličnosti. Ni indolentan odnos zastupnika države, ni dosadašnje gledanje kroz prste aplikantima ne izvinjava prvostepeni sud da *proprio motu* primijeni pravo koje poznaje po načelu *iura novit curia*. Odbacivanjem aplikacije, Veliko vijeće je otklonilo tu grešku i izbjeglo meritorno odlučivanje koje bi pratila opasnost od za mnoge neprihvatljivog proširivanja domašaja antidiskriminacione zaštite.

Međutim, aplikant nije jedini kome se mogu uputiti zamjerke, jer lista adresata obuhvata sve aktere ovog predmeta. Prvo, institucije BiH nisu uredile pravni okvir zastupanja države pred ESLJP, kršile su ZP

Rašević, Ž. i Pajić Šavija, S. (2025). Kovačević pred Evropskim sudom za ljudska prava: procesna farsa i sumnjiv presedan u antidiskriminacionoj praksi. *STED Journal*, 7(2), 50-65.

BiH i obmanjivale ESLJP o domaćem pravnom okviru zastupanja. Drugo, zastupnik BiH u prvostepenom postupku nije istakao sva neiskorišćena domaća pravna sredstva od strane aplikanta, te se na taj način ponašao kao nesavjesna stranka, podjednako kao aplikant. Naime, zastupnik nije obavijestio ESLJP o problemu sa njegovim ovlaštenjem za zastupanje, niti je objasnio koja je institucija BiH bila vlastodavac podnošenja zahtjeva za upućivanje predmeta pred Veliko vijeće. Ako te institucije nije bilo, nije pojasnio po kom je pravnom osnovu to učinio *proprio motu* i zašto baš u tom predmetu. Takođe, ne možemo da ne primijetimo i da pribjegavanje diskreditaciji aplikanta, istraživanjem njegovog etničkog izjašnjavanja, ne priliči uložiti zastupnika BiH koji kao institucija države treba da poštuje ljudska prava i dostojanstvo aplikanta i kada se nalazi na suprotnoj strani pred sudom. Treće, OHR je po prvi put intervenisao u predmet pred ESLJP, a da domaćoj javnosti nisu pojašnjeni motivi za njegov ovako iznenađan entuzijazam, kao i u kakvoj je to vezi sa njegovim mandatom. Četvrto, domaći sudija Vehabović nije iskoristio svoja ekspertiska znanja iz diskriminacionog prava, koje je demonstrirao u izdvojenom mišljenju uz drugostepenu presudu, da kao postupajući sudija u prvostepenom postupku ukaže da nisu bili iskorišćeni domaći pravni lijekovi (parnične tužbe zbog diskriminacije i povrede prava ličnosti), koje su u najmanju ruku djelotvorne kao aplikacija pred ESLJP. Na kraju, ESLJP nije uvjerljivo demantovao teške optužbe aplikanta o pristrasnosti Predsjedavajuće Kolegijuma i Predsjednika ESLJP. Uz dužno poštovanje prema ESLJP i njegovim sudijama, smatramo da nije dovoljno navesti u Presudi da se radi o „žalosnim“ i „klevetničkim“ optužbama, jer isticanje osnova sumnje treba da rezultira nezavisnom istragom koja, po svemu sudeći, nije preduzeta. Prema standardima pravičnog suđenja iz prakse ESLJP, svaki sud treba da ostavlja utisak nezavisnosti i nepristrasnosti [22, str. 31–33], a to bi trebalo da se odnosi i na ESLJP. Na taj način bi se djelotvorno demantovale optužbe člana Predsjedništva BiH o korumpiranosti Suda, Hrvatske i OHR koje su iznijete na globalnom forumu kakav je redovna sjednica

Generalne skupštine Ujedinjenih Nacija (UN) [23, 13].

Na kraju, čini se da je ključna pouka političkim elitama u BiH, koje već decenijama vode ogorčenu i nepomirljivu borbu za izborne i ustavne reforme po svojoj mjeri, da radikalne promjene ne bi bile opravdane. I prve reakcije na Presudu upućuju na ovaj zaključak. Čak i pravni savjetnik aplikanta i bivši sudija US BiH i Joseph Marko, iako smatra da ova presuda prijeti da poništi pravne posljedice ranije prakse ESLJP i da legitimise etno-nacionalne karte moći, predlaže samo minimalnu ustavnu intervenciju u korist tzv. „Ostalih.“ On nalazi da bi optimalno rješenje problema diskriminacije u izbornom procesu bilo amandmanima na članove IV i V Ustava BiH koji bi garantovali „Ostalima“ predstavljanje u Domu naroda PS i Predsjedništvu BiH. Ovo rješenje bi bilo blisko konsocijativnim modelima Sjeverne Irske i Južnog Tirola, jer bi to bio demokratski kompromis između principa etničkog predstavljanja sa jedne, i potpunog odbacivanja ovog principa, sa druge strane [24]. Time se ukazuje na stanovište ESLJP o opstanku konsocijativnog modela u BiH. To nije novost u jurisprudenciji Suda, jer i dosadašnji uvidi pokazuju da ESLJP smatra konsocijativnost dijelom BiH ustavnog identiteta [25, str. 141].

Sve u svemu, prezentovane tektonske pukotine u pravnom subjektivitetu i zastupanju BiH pred ESLJP iscrtavaju linije razdvajanja između političkih elita koje se sukobljavaju po pitanju ustavnih i izbornih reformi. U konačnici, odbacivanjem aplikacije, ESLJP nije podržao još jedan pokušaj da se rješenja tih sukoba pronalaze intervencijom međunarodnih institucija i uputio na unutrašnji dijalog i kompromis.

UTICAJ PRESUDE NA OPŠTU ZABRANU DISKRIMINACIJE

Predmet Kovačević je tek jedan od 22 predmeta pred ESLJP u kojima je, između ostalog, istaknuta povreda opšte zabrane diskriminacije iz P12 [26], pa se njen uticaj na razvoj antidiskriminacionog prava ne smije potcijeniti. Iako je okončan procesnom presudom kojom je stavljena van snage prvostepena presuda o povredi opšte zabrane

diskriminacije, u rezonovanju suda o nedostatku aplikantovog statusu žrtve se ipak nazire novi, suzdržaniji pristup ESLJP.

Najprije, nekoliko pojašnjenja o ustanova opšte zabrane diskriminacije iz P12 uz EK i njenoj (ne)korisnosti u domaćem pravnom sistemu. Radi se o novoj i nedovoljno afirmisanoj ustanova, jer se početni optimizam u njenom afirmisanju nije opravdao u njenoj već dvodecenijskoj pravnoj egzistenciji. Naime, priređivači P12 i proponentni antidiskriminacionog diskursa su očekivali da ova ustanova evoluirala nediskriminaciju od tradicionalno shvaćenog načela uživanja ljudskih prava, supsidijarnog i akcesornog karaktera u odnosu na subjektivna prava [27, str. 111–121], do samostalnog ljudskog prava [28, str. 30–44], [29]. U tom smislu, P 12 u članu 1. izričito zabranjuje javnim vlastima diskriminaciju po bilo kom osnovu, a proširuje antidiskriminacionu zaštitu sa uživanja prava iz EK na sva prava utvrđena zakonom. Autentični tumač komentariše da to obuhvata i više, tj. prava koja se mogu izvesti iz jasnih obaveza, diskrecionih ovlašćenja, ili pak bilo kog činjenja ili propuštanja javne vlasti [30]. Međutim, od stupanja na snagu dana 01.04.2005. godine, do sada P 12 nije prihvaćen od strane većine država SE (čak 26 članica), uključujući Ujedinjeno Kraljevstvo, Francusku, Njemačku, Rusiju, Švajcarsku i Dansku. To nije iznenađujuće jer je u literaturi ljudskih prava poznato da evropski pristup zabrani diskriminacije uvijek zaostajao za standardima UN, ograničavajući se samo na prava iz EK [31, str. 128]. Ova ustanova je naišla i na žestoka protivljenja u literaturi privatnog prava, jer se pretjerano širenje antidiskriminacione zaštite smatra društveno opasnom i štetnom po privatnost, autonomiju volje i preduzetništvo [32], [33]. Za razliku od država-lidera ljudskih prava, koji nisu prihvatili ovu ustanovu, BiH je jedna od prvih država koja je ratifikovala P12 [34], a sada je i šampion po broju osuđujućih presuda: Od ukupno 14, BiH je dosuđena povreda P12 u 8 predmeta (uključno sa prvostepenom presudom u ovom predmetu), Srbiji u 2, a Sloveniji, Albaniji, Rumuniji i Ukrajini u jednom [26]. Kada se ima u vidu ova porazna neprihvaćenost P12 u vodećim zapadnim pravnim sistemima i dosuđivanje povreda

uglavnom siromašnim post-komunističkim državama, potvrđuje se ranija ocjena o balkanizaciji nediskriminacije, kako u doslovnom, tako i u prenesenom, pežorativnom značenju [15, str. 45]. Nema sumnje da BiH, kao postkonfliktno i duboko podijeljeno društvo, nije podesan teren za bilo kakvo egalitarističko socijalno eksperimentisanje, pa postavljanje ovako visoko postavljene ljestvice u zaštiti od diskriminacije izgleda kao dalje produbljivanje jaza između normativnog i realnog. Tako i bivši sudija ESLJP Mijović smatra da se radilo o nepromišljenom potezu domaćih vlasti [35, str 14]. Moglo bi se reći da se radi o pukom deklarisanju privrženosti progresivnim evropskim vrijednostima u mjeri koja prevazilazi entuzijazam čak i vodećih promotera ljudskih prava. Dosuđene povrede P 12 demonstriraju da je od P 12 do sada bilo više štete nego koristi, jer njegova implementacija nije bitno doprinijela suzbijanju diskriminacije, a žestoko je uzdrmala nedovršeni i nestabilni pravni sistem BiH.

Iako je postupak pred ESLJP u konkretnom slučaju okončan procesnom presudom, iz rezonovanja ESLJP se ipak može uočiti zaokret u primjeni P 12. Kada se uporede dosadašnje presude, može se uočiti da je i ova aplikacija krenula utabanim stazama ranijih uspjeha, jer se i u njoj ističe etnički i teritorijalni osnov diskriminacije. Takođe, neizjašnjavanje aplikanta o etničkoj pripadnosti nije novina, jer je već bilo uspješno istaknuto u predmetu Zorić. Nije novost ni isticanje sa diskriminacijom povezanog aktivnog, umjesto pasivnog biračkog prava, jer je u predmetu Baralija dosuđena povreda opšte zabrane diskriminacije u uživanju oba, i aktivnog i pasivnog. Kontinuitet u tumačenju opšte zabrane diskriminacije se može pronaći i u prvostepenoj dosudi opšte zabrane diskriminacije, bez jasnog identifikovanja koje je to subjektivno pravo određeno domaćim zakonom, korespondentnom obavezom, diskrecionim pravom ili činjenjem/nečinjenjem javne vlasti, kako to nalaže gore objašnjeno slovo i tumačenje člana 1. P 12. Kako je već nagoviješteno gore, sistemsko tumačenje Ustava BiH i IZ ukazuje

da izborno pravo ne uključuje subjektivno pravo da se glasa i bude izabran u Dom naroda PS BiH i Predsjedništvo BiH. Ako nema povezanog prava, nema ni diskriminacije u njegovom uživanju. To, međutim, ne predstavlja specifičnost pravnog poretka BiH, ako se ima u vidu da se u uporednom pravu mogu pronaći mnogi primjeri legitimnih ograničenja izbornog prava za jedan od skupštinskih domova ili šefa države, koji se, štaviše, monarhijama uopšte ne biraju demokratski. Bilo kako bilo, Veliko vijeće je u ovom predmetu prekinulo kontinuitet zaštite, zaključujući da aplikant nije žrtva, a tome se ima štošta prigovoriti. Prije svega, nisu navedeni ubjedljivi razlozi u razlikovanju statusa žrtve u odnosu na kandidovanje i na glasanje, jer u oba slučaja nematerijalna šteta koju aplikant trpi se sastoji u približno istom duševnom bolu zbog diskriminacije. Dalje, nije sporno da je ESLJP mogao da bude zbunjen nedovoljno jasnim, pa možda i pogrešnim pravnim kvalifikacijama aplikanta o osnovu diskriminacije i komparatoru. Ipak, prezentovano činjenično stanje mu je omogućavalo da kao legitiman i nesporan osnov diskriminacije prepozna neki drugi osnov, a to bi moglo da bude političko uvjerenje aplikanta o nekonsocijalnom modelu budućnosti BiH i minimiziranju mogućnosti da bira predstavnike koji bi to omogućili. To bi ukazalo na nepovoljniji tretman aplikanta u odnosu na komparator, a to bi bila lica koja, bila etnički deklarirana ili ne, podržavaju konsocijativni model i stoga imaju više mogućnosti za izbor kandidata sa istovjetnim političkim uvjerenjima. Ako se aplikantova situacija postavi na ovaj način, njegov nepovoljan tretman po osnovu političkog uvjerenja kao legitimnog osnova za kvalifikaciju diskriminacije je zaista postojao. Sama činjenica nepovoljnog tretmana bi trebalo da bude dovoljna za priznavanje statusa žrtve, jer diskriminacija u vezi sa uživanjem nekog prava može da postoji i kada to pravo nije prekršeno [36, str. 25]. U prilog tome govori i novija literatura koja ukazuje da raspodjela tereta dokazivanja u zaštiti od diskriminacije treba da bude poštenija, tj. blaža za aplikanta [37, str. 444–446]. U tom smislu bi trebalo podržati stav sudije Vehabovića da se ovom presudom postavlja

previsok prag za utvrđivanje statusa žrtve koji može da umanji rezultate ESLJP u suzbijanju diskriminacije.

U pogledu dosuđene zloupotrebe prava na aplikaciju, ESLJP je strogo ocijenio dopuštenost aplikantovih motiva za izlazak pred taj sud. U stavu 131. sud je pojasnio da se ova zloupotreba treba razumjeti u smislu opšte pravne teorije kao štetno vršenje prava za ciljeve drugačije od onih zbog kojih je to pravo ustanovljeno. Pri tome je teorijska učenja o zloupotrebi prava upotrijebio selektivno, jer nije utvrđivao da li je aplikant imao u vidu samo jedan nedopušten cilj ili je bilo i onih koji su dopušteni. Detaljnije obrazloženje je bilo potrebno jer opšta teorija, na koju se ESLJP pozvao, upozorava da utvrđivanje protivciljnosti prati opasnost od političke arbitarnosti i zloupotrebe ovog nepreciznog kriterijuma [38, str. 8–10, 19]. Nedostatak ranije ispoljene tolerantnosti u ocjeni motiva aplikanta udaljava ovaj predmet od preporuka literature antidiskriminacionog prava o napuštanju tradicionalnog adversarnog pristupa kojim se pruža individualna zaštita pojedincu koji je ujedno žrtva, glasnogovornik onih kojima su ljudska prava povrijeđena i imalac povrijeđenog ljudskog prava. Prema njima, prava mjera antidiskriminacione zaštite jeste grupna tužba u kojoj žrtve nisu pojedinci nego grupe, a glasnogovornik čak i ne mora da bude dio te grupe [39, str. 170–174]. Zato zaključak Suda da je aplikant zloupotrijebio pravo na aplikaciju, jer mu je cilj bio promjena državnog uređenja umjesto zaštite svog prava, izgleda kao pretjerana restriktivnost kojom se ignoriše složenost same prirode zaštite od diskriminacije i obeshrabruju diskriminirani ta potraže zaštitu pred ESLJP. Ta zaštita mora da ima širi domašaj od puke zaštite pojedinca, jer ciljevi individualne zaštite aplikanta i borbe protiv diskriminatornih javnih politika ne isključuju jedan drugi, nego se prožimaju.

Sve to ukazuje da je ESLJP odustao od ranijeg proaktivnog pristupa u suzbijanju systemske diskriminacije. U odnosu na BiH, taj pristup se uglavnom svodio na ishodovanje deklarativnih presuda po aplikacijama aktera političkog života u BiH, koji su u većoj ili manjoj mjeri imali političke ciljeve, koji prevazilaze individualnu zaštitu. Ova nova suzdržanost ESLJP ne priliči instituciji za

suzbijanje diskriminacije, ali se može opravdati zbog umanjivanja rizika od zloupotrebe P 12 u svrhe političkog potkusurivanja u BiH. Pouka teoretičarima, praktikantima i aktivistima ljudskih prava je da od ustanove primjene P12 ne treba očekivati mnogo zbog kazuističkih lutanja i nedostatka koherentne prakse ESLJP.

ZAKLJUČAK

U predmetu Kovačević, aplikant je, poslije ekspresno izvojevane pobjede protiv BiH u isticanju povrede opšte zabrane diskriminacije u uživanju prava da glasa za kandidate u skladu sa svojim političkim uvjerenjem (član 1. P 12 u vezi sa članom 3. P1 uz EK), doživio procesni poraz u postupku pred Velikim vijećem ESLJP, zbog ocjene Suda o nedostatku statusa žrtve upotrebe prava na aplikaciju iz člana 35. stav 3. EK. Ova presuda predstavlja presedan kojim je prekinut niz uspjeha aplikanata, uglavnom aktera političkog života, protiv BiH, a koji su se sastojali u deklarativnim presudama ESLJP o povredi ove ustanove i posljedičnoj potrebi da se diskriminacija suzbije izbornim, a možda i ustavnim promjenama.

Postupak pred ESLJP je bio obilježen uzajamnim optužbama i pokušajima diskreditacije između svih procesnih subjekata. To pobuđuje zabrinjavajuće sumnje o pravnoj neuređenosti zastupanja države pred ESLJP, nesavjesnom parničanju zastupnika države i kršenju zakona od strane najviših državnih institucija BiH, te o pristrasnosti OHR i pojedinih sudija ESLJP. Što se donesenih presuda tiče, one izvjesno neće biti korisne za dalji razvoj antidiskriminacionog prava, kako zbog iznenadne suzdržanosti suda u suzbijanju diskriminacije, tako i zbog nedosljedne argumentacije. Drugim riječima, aktivizam ESLJP u pravcu reforme diskriminirajućih ustavnih i izbornih normi je iznenada splasnuo, a razlozi za to u predmetnoj posudi izgledaju neubjedljivo, ili barem nedorečeno.

Sa druge strane, okončanje predmeta pred ESLJP uskraćivanjem zaštite aplikantu je jasna poruka sukobljenim političkim i drugim elitama u BiH da svoja neslaganja počnu da rješavaju unutrašnjim dijalogom i osloncem na domaće pravosuđe, umjesto da očekuju

ekspresnu i bezrezervnu podršku ESLJP za svoje agende i projekcije uređenja BiH. Takav pristup svakako odgovara misiji ESLJP u individualnoj zaštiti ljudskih prava, ali ne pogoduje instituciji koja bi trebalo da se nalazi u prvom ešalonu evropskih institucija u borbi protiv diskriminacije.

Primjer ovog, a i ranijih predmeta ESLJP protiv BiH o povredi P12 pokazuju sve mane implementacije P 12 u BiH, jer pozitivisanje ove ustanove nije značajnije doprinijelo suzbijanju diskriminacije, a iskorišćeno je za političke zloupotrebe. Zato ne treba očekivati veće pomake u prihvatanju opšte zabrane diskriminacije i antidiskriminacionog prava uopšte, kome već hronično nedostaju ubjedljiviji teorijski pristupi [40, str. 137]. Ovo pogotovo što diskurs o društvenoj jednakosti postaje sve manje popularan, zbog narastajućih globalnih trendova zveckanja oružjem, nelegalnih migracija i širenja autoritarizma. To će navesti države da u pogledu implementacije P12 budu još promišljenije i opreznije. Nadamo se da će i BiH krenuti tim razumnim putem.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURA

1. European Court of Human Rights. (2025). Grand Chamber, Kovačević v. BiH, 43651/22, 25.06.2025.
2. European Court of Human Rights. (2009). Grand Chamber, Sejdić & Finci v. BiH 27966/06 i 34836/06, 22.12.2009.
3. European Court of Human Rights. (2014). Zornić v. BiH, 3681/06, 15.07.2014.
4. European Court of Human Rights. (2016). Šlaku v. BiH, 56666/12, 26.5.2016.
5. European Court of Human Rights. (2016). Pilav v. BiH, 41939/07, 09.06.2016.
6. European Court of Human Rights. (2019). Baralija v. BiH, 30100/18, 29.10.2019.
7. European Court of Human Rights. (2020). Pudarić v. BiH, 55799/18, 08.12.2020.
8. European Court of Human Rights. (2014). Vučković et al. v. Serbia, 1753/11 et al., 25.3.2014.

Rašević, Ž. i Pajić Šavija, S. (2025). Kovačević pred Evropskim sudom za ljudska prava: procesna farsa i sumnjiv presedan u antidiskriminacionoj praksi. *STED Journal*, 7(2), 50-65.

9. Zakon o obligacionim odnosima, Službeni list SFRJ, 29/78, 45/89, 57/89, Službeni list RBiH, 27/92, 13/93 i 13/94, Službene novine FBiH, 29/03 i 42/11.
10. Zakon o zabrani diskriminacije, Službeni glasnik BiH, 59/09, 66/16.
11. Mojović, N. (2010). *Presuda Evropskog suda za ljudska prava u predmetu Sejdić-Finci, Izlaganje*. Banja Luka: Akademija nauka i umjetnosti Republike Srpske.
12. Vehabović, F. (2010). *Komentar Zakona o zabrani diskriminacije*. Sarajevo: Centar za ljudska prava Univerziteta u Sarajevu.
13. Concile of Europe, Directorate of Programme Co-ordination, Strasbourg. (2024). Croatia makes a voluntary contribution to support the European Court of Human Rights, 06.11.2024. Preuzeto 15.10.2025. sa: <https://www.coe.int/en/web/programmes/-/croatia-makes-a-voluntary-contribution-to-support-the-european-court-of-human-rights>
14. Izborni zakon, Službeni glasnik BiH, 23/2001, 7/2002, 9/2002, 20/2002, 25/2002 - ispravka, 4/2004, 20/2004, 25/2005, 77/2005, 11/2006, 24/2006, 33/2008, 37/2008, 32/2010, 48/2011 - odluka US, 63/2011 - odluka US, 18/2013, 7/2014, 31/2016, 54/2017 - odluka US, 41/2020, 38/2022, 51/2022, 67/2022, 24/2024 i 24/2024 – ispravka.
15. Rašević, Ž. (2016). Ten Years of the ECHR Protocol 12: the Balkanisation of Non-Discrimination. *Central and Eastern European Legal Studies* 1, 2016.
16. European Court of Human Rights. (1987). Mathieu-Mohin i Clerfayt v. Belgium, ser-A-113, 02.03.1987.
17. Rutherglen, G.A. (2020). Disaggregated Discrimination and the Rise of Identity Politics. *William & Mary Journal of Race, Gender, and Social Justice*, 26(2), 391-423.
18. European Court of Human Rights. (2021). *Poslovnik Suda*. Strasbourg: Tajništvo Suda (hrvatski prevod). Preuzeto 10.10.2025 sa: <https://uredzastupnika.gov.hr/UserDocsImages/dokumenti/POSLOVNIK/Poslovnik%20E SLJPa.pdf>
19. European Court of Human Rights. (2024). Grand Chamber hearing - 20 November 2024, (video zapis). Preuzeto 27.09.2025. sa: https://www.echr.coe.int/w/kovacevic-v.-bosnia-and-herzegovina-no.-43651/22-?p_1_back_url=%2Fweb%2Fechr%2Fsearch%3Ffolder%3D709108%26q%3D%25243651%2F22%2522&p_1_back_url_title=Search
20. Zakon o Pravobranilaštvu BiH, Službeni glasnik BiH, 8/02, 10/02, 44/04, 102/09 i 47/14.
21. Jakšić, A. (2006). *Evropska konvencija o ljudskim pravima, komentar*. Beograd: Centar za publikacije Pravnog fakulteta u Beogradu.
22. Mole, N., & Harby, C. (2006). *The Right to a Fair Trial*. Strasbourg: Directorate General of Human Rights, Council of Europe.
23. Vijesti HRT. (2025). Komšić u UN-u optužio Hrvatsku, Schmidta i ESLJP za korupciju. Preuzeto 26.09.2025. sa: <https://vijesti.hrt.hr/svijet/komsic-u-un-u-optuzio-hrvatsku-schmidta-i-esljp-za-korupciju-12352708>
24. Marko, J. (2025). A Fallen Curtain and Open Questions, The Grand Chamber Decision of the European Court of Human Rights in Kovačević v. Bosnia and Herzegovina. Retrieved August 31 2025, from <https://verfassungsblog.de/ecthr-voting-bosniaherzegovina/>.
25. Muharemović, M., & Nurkić, B. (2024). Balancing Democracy and Human Rights: The Role of Constitutional Identity in the ECHR's Recent Jurisprudence. *Bratislava Law Review*, 8(2), 131-146.
26. European Court of Human Rights. (2025). Hudoc. Preuzeto 20.09.2025 sa: <https://hudoc.echr.coe.int>
27. Dimitrijević, V., Popović, D., Papić, T., Petrović, V. (2007). *Međunarodno pravo ljudskih prava*. Beograd: Beogradski centar za ljudska prava i Dosije.
28. Fredman, S. (2001). Combating Racism with Human Rights: The Right to Equality. In S. Fredman (ed.) *Discrimination and Human Rights*. Oxford: University Press.
29. Karvatska, S., & Toronchuk, I. (2020). The Right to Non-Discrimination: Interpretative Practice of the ECHR.

Rašević, Ž. i Pajić Šavija, S. (2025). Kovačević pred Evropskim sudom za ljudska prava: procesna farsa i sumnjiv presedan u antidiskriminacionoj praksi. *STED Journal*, 7(2), 50-65.

- European Journal of Law and Public Administration*, 7(2), 24-38.
30. Concile of Europe. (2000). Explanatory Report to the Protocol No. 12 to the Convention for the Protection of Human Rights and Fundamental Freedoms. Rome: CoE.
 31. van Boven, T. (2001). Discrimination and Human Rights Law. In S. Fredman (ed.) *Discrimination and Human Rights*. Oxford: University Press.
 32. Mansel, H. (2007). Allgemeines Gleichbehandlungsgesetz - persönlicher und internationaler Anwendungsbereich. In A. Heldrich (ed.) *Festschrift für Claus-Wilhelm Canaris zum 70*. München: C.H.Beck.
 33. Brownsword, R. (2001). Freedom of Contract, Human Rights and Human Dignity. In D. Friedman, D. Barak-Erez (eds.) *Human Rights in Private Law*. Oxford: Hart Publishing.
 34. Koba, L. (2025). Anti-discrimination Policy in BiH. *Przegląd Europejski – European Studies Quarterly*, 2025(1), 91-106.
 35. Mijović, Lj. (2010). *Presuda Evropskog suda za ljudska prava u predmetu Sejdić-Finci, Uvodno izlaganje*. Banja Luka: Akademija nauka i umjetnosti Republike Srpske.
 36. Rašević, Ž. (2014). *Zabrana diskriminacije u privatnom pravu*. Beograd: Zadužbina Andrejević.
 37. Henrad, K. (2023). The European Court of Human Rights and the ‘Special’ Distribution of the Burden of Proof in Racial Discrimination Cases: The Search for Fairness Continues. *European Convention of Human Rights Law Review* 4(4), 426-446.
 38. Vodinić, V. (1997). *Takozvana zloupotreba prava*. Beograd: Nomos
 39. Fredman S. (2002). *Discrimination Law*. Oxford: University Press.
 40. Rutherglen, G.A. (2012). Concrete or Abstract Conceptions of Discrimination? *Virginia Public Law and Legal Theory Research Paper*, 2012(58), 2148435.

Rašević, Ž. i Pajić Šavija, S. (2025). Kovačević pred Evropskim sudom za ljudska prava: procesna farsa i sumnjiv presedan u antidiskriminacionoj praksi. *STED Journal*, 7(2), 50-65.

KOVAČEVIĆ BEFORE THE EUROPEAN COURT OF HUMAN RIGHTS: A PROCEDURAL FARCE AND A DUBIOUS PRECEDENT IN DISCRIMINATION JURISPRUDENCE

Živorad Rašević¹, Sandra Pajić Šavija²

¹University PIM, Faculty of Law, despota Stefana Lazarevića, bb, 78 000 Banja Luka, Bosnia and Herzegovina, rasevic71@gmail.com

²Faculty of Business Economics and Entrepreneurship, Mitropolita Petra 8, 11 000 Belgrade, Serbia, sandra_pajic@yahoo.com

ORIGINAL SCIENTIFIC PAPER

ISSN 2637-2150

e-ISSN 2637-2614

DOI 10.63395/STEDJournal0702090S

UDC 341.645.5(4):341.231.14

COBISS.RS-ID 143560449

Received: 02 November 2025.

Revised: 07 November 2025.

Accepted: 14 November 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Corresponding Author: Živorad Rašević,
University PIM, Faculty of Law, despota
Stefana Lazarevića, bb, 78 000 Banja Luka,
Bosnia and Herzegovina,
rasevic71@gmail.com



Copyright © 2024 Živorad Rašević
& Sandra Pajić Šavija; published by
UNIVERSITY PIM. This work licensed under
the Creative Commons Attribution-
NonCommercial-NoDerivs 4.

Citation: Rašević, Ž. i Pajić Šavija, S. (2025).
Kovačević before the European court of
human rights: Procedural Farce and a Dubious
Precedent in Anti-Discrimination Practice.
STED Journal, 7(2), 50-64.
<https://doi.org/10.63395/STEDJournal0702090R50>

ABSTRACT

This paper employs methods of legal dogmatics and draws upon theoretical insights from procedural and anti-discrimination law to

explain the proceedings and assess the reasoning of the European Court of Human Rights (ECtHR) in the case *Slaven Kovačević v. Bosnia and Herzegovina* (BiH), application no. 43651/22. In this case, the applicant initially achieved another swift victory by successfully invoking a violation of the general prohibition of discrimination under Article 1 of Protocol No. 12 (P12) to the European Convention on Human Rights (ECHR) in the enjoyment of his right to vote for candidates according to his political conviction under Article 3 of Protocol No. 1. However, after this victory was challenged, he suffered an unexpected procedural shipwreck before the ECtHR Grand Chamber, which found that the applicant was not a victim of discrimination and had even abused his right of individual application. The paper further discusses the possible implications of this judgment for the future development of Protocol No. 12 and anti-discrimination law more broadly. A detailed examination of the conduct and reasoning of all procedural actors reveals indications of improper use of procedural powers, bias among participants, and the lack of a coherent legal framework for the representation of Bosnia and Herzegovina before the ECtHR.

The was not the only one who deserved procedural reproach. First, the institutions of BiH violated the legal framework for representation before the ECtHR. Second, the Agent of the state in the first-instance proceedings failed to address all unused domestic remedies and failed to inform the Court of its legally unsound status. Besides, the agent failed to clarify which BiH institution authorised his representation, or what was the legal basis for that if he/she had

Rašević, Ž. i Pajić Šavija, S. (2025). Kovačević pred Evropskim sudom za ljudska prava: procesna farsa i sumnjiv presedan u antidiskriminacionoj praksi. *STED Journal*, 7(2), 50-65.

acted *proprio motu*. Third, OHR intervened for the first time in a case before the ECtHR but failed to explain the motives for his sudden enthusiasm in this case. Fourth, during the first-instance proceedings, the BiH judge did not warn that all effective domestic legal remedies had not been exhausted. Finally, the ECtHR did not convincingly refute the applicant's serious allegations concerning the impartiality of the Court.

The procedural shipwreck of the applicant before the Grand Chamber suggests a departure by the Court from its previous proactive approach to the application of

Protocol No. 12 and a retreat from further engagement with the structural issues of BiH's consociational system. However, such a restrained approach seems inconsistent with the mission of the Council of Europe's institution in combating discrimination, and the Court's inconsistent reasoning is unlikely to contribute to the conceptual development of anti-discrimination law or to encourage wider ratification of the still insufficiently accepted Protocol No. 12.

Keywords: general prohibition of discrimination, right to vote, victim status, abuse of the right of individual application.

THE EUROPEAN UNION GROWTH PLAN FOR THE WESTERN BALKANS AS A FORM OF FASTER INTEGRATION INTO THE EU SINGLE MARKET

Manja Đurić Džakić

University of Banja Luka, Faculty of Political Sciences, Bulevar vojvode Petra Bojovića 1A,
78 000 Banja Luka, Bosnia and Herzegovina, manja.djuric@fpn.unibl.org

REVIEW SCIENTIFIC PAPER

ISSN 2637-2150

e-ISSN 2637-2614

DOI 10.63395/STEDJournal0702080DJ66

UDC 341.217(4-672EU):339.923

COBISS.RS-ID 143560961

Received: 11 July 2025.

Revised: 24 October 2025.

Accepted: 29 October 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Corresponding Author: Manja Djuric Dzakic,
University of Banja Luka, Faculty of Political
Sciences, Bulevar vojvode Petra Bojovića 1A,
78 000 Banja Luka,
manja.djuric@fpn.unibl.org



Copyright © 2025 Manja Đurić Džakić; published by UNIVERSITY PIM. This work licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.

Citation: Đurić Džakić, M (2025). The european union growth plan for the Western Balkans as a form of faster integration into the EU single market. *STED Journal*, 7(2), 66-73. <https://doi.org/10.63395/STEDJournal0702080DJ66>

ABSTRACT

This paper aims to explore the structure and objectives of the Western Balkans Growth Plan as an incentive for the integration of the Western Balkans region into the EU single market. In november 2023, the European Commission prepared the Western Balkans Growth Plan, which should accelerate the implementation of reforms in the countries of

the region and their integration into the European Union single market. The Growth Plan represents an effort by the European Union to influence the region towards deepening economic integration with the Union and accelerating economic growth, which are necessary prerequisites for the desired transformation of the countries of the region. The Western Balkans Growth Plan aims to: integrate partners from the Western Balkans into the EU single market, improve regional economic cooperation, deepen EU-related reforms, and increase pre-accession financing to accelerate the socio-economic convergence of the Western Balkans towards the EU. The research results of this paper have shown that the European Union in the Western Balkans region, from the first regional approach in 1997 to the proposed growth plan in 2023, has contributed to the development of the regional cooperation process and the economic development of the region itself.

It is not just about increasing the wealth of the countries of the region and their citizens, but the point and ultimate goal is that these countries and these citizens should live together, create, cooperate and spend together in conditions of international competition.

The countries of the Western Balkans region have small and open economies and growing trade. The European Union is the main foreign trade partner in the region, accounting for over 70% of the region's exports to the European Union and 70% of the region's imports from the European Union.

The expected economic effects of the Western Balkans Growth Plan will also ensure a positive perception of the European Union and the benefits of membership in this regional organization among the citizens of the region.

Keywords: Western Balkans, The accession process, Growth Plan, EU single market.

INTRODUCTION

The Growth Plan for the Western Balkans is an initiative of the European Union intended for the candidate countries for membership Albania, Bosnia and Herzegovina, Kosovo², Montenegro, North Macedonia and Serbia in order to speed up the accession process. This plan aims at faster integration into the single market of the European Union, and at the same time requires stronger regional economic cooperation, which is expected to lead to the acceleration of economic rapprochement with the Union.

The creation of a single market is the basis of European integration. Without it, European interaction would not be possible and would lose its founding goal. The single market represents a physical-geographical and economic unique space within which there are no economic borders and in which the four freedoms are fully applied: freedom of movement of goods, freedom of movement of people, freedom of provision of services and freedom of movement of capital.

The growth plan for the Western Balkans is based on four pillars that represent a combination of obligations for the Western Balkans and incentives for fulfilling those obligations. The first two pillars envisage the strengthening of regional economic integration, and then the gradual accession of the region to the EU single market, which represents the opening of the EU to the countries of the region in order to better prepare them for membership itself. The third pillar entails the obligation of governments to prepare reform agendas, which will contain reforms and investment priorities, and upon successful fulfillment of which the conditions will be met for the withdrawal of funds provided for in pillar four. The fourth pillar envisages a package of 6 billion euros for the Western Balkans in the period 2024-2027. in relation to 2 billion euros of non-reimbursable support and 4 billion euros of soft loans.

According to initial estimates, Albania would receive 922 million euros, Bosnia and Herzegovina 1.085 billion euros, Kosovo 882 million euros, Montenegro 383 million euros,

North Macedonia 750 million euros and Serbia 1.58 billion euros [1].

THE APPROACH OF THE EUROPEAN UNION TOWARDS THE WESTERN BALKANS REGION

In May 1999, the European Commission proposed a specific approach to the Western Balkans countries, called the Stabilization and Association Process (SAP). The Council of the European Union adopted the proposal in June 1999 at its meeting in Luxembourg, and the process was opened to the countries of the region: Albania, Bosnia and Herzegovina, North Macedonia, Serbia, Kosovo, Montenegro and Croatia, (until Croatia become member of the European Union in 2013). The term Western Balkans is political and is used to distinguish this group of countries from the previous ones that have already established relations with the European Union. According to Dragan Đukanović, the term Western Balkans is a "geopolitical construct", which was created in 1999 after the breakup of the SFR Yugoslavia, located on the very periphery of modern Europe with numerous latent forms of instability, which carry the risks of spreading local crises to neighboring subregions and beyond [2, p.353].

Achieving and deepening political integration in the diverse identity, cultural and linguistic context of the Western Balkans region is an extremely difficult and long-term process, even though the motto of the European Union is united in diversity, as Miloš Jovanović has so aptly noted [3].

The aim of the Stabilization and Association Process is to establish regional cooperation in order to achieve first stabilization [4, p.36] and then the accession of the countries of the region to the Union, while maintaining balanced progress for these countries.

The Stabilization and Association Process is based on several instruments, the most important of them is Stabilization and Association Agreement (SAA), economic and financial assistance through the CARDS program as the main financial instrument for implementing reforms by 2006 [5] (today IPA III), democratization of society based on the rule of law, development of political dialogue,

²According to United Nations Security Council resolution 1244 (United Nations, 1999).

cooperation in the field of justice and home affairs, and humanitarian assistance for refugees, returnees and other socially vulnerable persons. This entire process was also based on insisting on the improvement of democracy, civil society [6], education, institution-building with the help of European funds, providing humanitarian and any other assistance to vulnerable persons, using new opportunities for cooperation and strong regional connectivity.

Among the biggest problems faced by the countries of the Western Balkan region, can be count the insufficient level of government law as well as the lack of good or democratic governance, the conditions for law enforcement are limited by the inefficiency of public administrations in all countries, the states have been hijacked by powerful private interests, and are unable to provide citizens with the most important public goods [7].

Within the framework of the Stabilization and Association Process, it is necessary to fulfill the Copenhagen criteria, which represent the conditions for membership in the European Union. The criteria were set at the Copenhagen European Council in 1993.

These are three criteria: political, economic and legal [8]:

- political - stability of institutions ensuring democracy, the rule of law, respect for human rights and the protection of minorities,
- economic - the existence of a functioning market economy, capable of coping with competitive pressure and market forces within the Union,
- legal - the ability to take on the obligations of membership, including commitment to the objectives of political, economic and monetary union.

The Madrid criterion was set at the 1995 European Council. This criterion refers to the adjustment of the administrative structure [9] with the aim of creating the conditions for gradual and harmonious integration. It involves strengthening administrative capacity and creating an efficient state administration system for implementing the *acquis communautaire* and other obligations arising from membership of the European Union. Economic criteria are

an important part of the European integration process of all countries aspiring to membership in the European Union. Before full accession, each candidate country must build a functioning market economy that has the capacity to withstand competitive pressure within the EU's single market [10]. The Stabilisation and Association Process reaffirms the objectives of the previous policy of the European Union, whereby, in addition to peace and stability, democracy and the rule of law, respect for human and minority rights, economic prosperity and the promotion of regional cooperation, it now seeks to make the European perspective of this region more certain. This approach related to meeting criteria is also called the European Union's conditionality policy [11]. However, this is a Union policy that, in the overall balance, must be assessed as successful, because no matter how distant, the prospect of EU membership has been the anchor of all positive changes in the Western Balkans region [12].

The Stabilisation and Association Agreement reflects the Union's willingness to improve the speed, quality and visibility of external assistance, as well as its effectiveness. The Agreement is based on respect for democracy and human rights, the rule of law and the market economy. The process of economic-systemic reforms, the process of liberalization and integration, along with the strengthening of the market economy and the role of citizens in society, have a positive development effect [13].

According to Sotiroski, the countries of the Western Balkans are turning to the European Union to accelerate their economic recovery, improve their mutual relations (long marked by ethnic and religious wars), and consolidate their democratic institutions and their proper functionality. Recommendations to the institutions of the European Union, which, according to this author, could revive the accession process of the Western Balkans, regardless of the need for sincere reforms in the countries that want to become members, include removing bilateral disputes from the accession agenda, stronger support for democratic forces in the region, revitalizing the enlargement process, and greater financial

Đurić Džakić, M (2025). The european union growth plan for the Western Balkans as a form of faster integration into the EU single market. *STED Journal*, 7(2), 66-73.

assistance through available financial instruments [14].

The primary objective of the Stabilisation and Association Agreement of the Western Balkans region with the European Union is formal association during a certain transitional period, during which the legislation will be gradually adjusted to the most important standards and rules of the European Union's internal market.

The Stabilisation and Association Agreement constitutes a contractual relationship between the European Union and the Western Balkan countries and the legal basis for the entire stabilisation and association process. The credibility of each of the countries of the region that wishes to be a candidate for accession to the Union depends on the success in implementing the agreement. The structure of the Stabilization and Association Agreement consists of a preamble and ten chapters that represent the most important areas of reform [15]:

- general principles,
- political dialogue,
- regional cooperation,
- free movement of goods,
- movement of workers, establishment, provision of services, movement of capital,
- approximation of laws, enforcement of laws and competition rules,
- justice, freedom and security,
- cooperation policies,
- financial cooperation,
- institutional, general and final provisions.

„Economic reforms must be decisively implemented in order to eliminate structural weaknesses, low competitiveness and high unemployment. Given that all the countries of the Western Balkans are facing the same or similar problems arising from the weakness of state structures that are manifested in the fight against corruption, organised crime, terrorism, cybercrime, illegal migration, trafficking in arms, drugs and people, and other hybrid threats, which jeopardise vital national interests, judicial and public administration reforms should bring some real and visible results with the aim of the more efficient

functioning of state institutions and the final establishment of the rule of law“ [16, 359-360].

GROWTH PLAN FOR THE WESTERN BALKANS

In November 2023, the European Commission proposed a Growth Plan for the Western Balkans based on four pillars [17, p.2]:

- The first pillar refers to the strengthening of economic integration with the single market of the European Union.
- The second pillar encourages the strengthening of the economic integration of the countries of the Western Balkans through a Common Regional Market.
- The third pillar refers to the acceleration of fundamental reforms, which will support the progress of the Western Balkans towards membership in the Union and improve sustainable economic growth.
- The fourth pillar implies an increase in financial assistance for reforms through the instrument for reforms and growth for the Western Balkans, a new instrument within which 6 billion euros of grant support and aid are available in the form of loans, from which the funds will be disbursed on the condition that the partners from the Western Balkans implement fundamental reforms.

In order to achieve the goals of the new Growth Plan for the Western Balkans, special emphasis when it comes to investment areas should be placed on sectors that are likely to be key multipliers of social and economic development: connectivity, sustainable transport, decarbonization, energy, green and digital transition, as well as education and skills development, with a special emphasis on youth [18].

STRUCTURE AND OBJECTIVES OF THE GROWTH PLAN FOR THE WESTERN BALKANS

The first pillar - Strengthening economic integration with the single market of the European Union

Integration with the single market of the European Union is the main driver of economic growth in all countries that joined the Union.

The goal is to bring the economies of the region closer to the single market after the necessary level of readiness is achieved. The seven priority measures for integration into the single market established by the Commission as part of the growth plan include: free movement of goods, free movement of services and workers, access to the single euro payment area, facilitation of road traffic, integration and decarbonization of energy markets, single digital market and integration into industrial supply chains.

Priority measures can be implemented by applying the existing legal basis of the Stabilization and Association Agreement, targeted supplementary agreements or, if necessary, by amending the existing agreements on the transport community and the energy community agreement [17, pp.3-5].

Second pillar - Encouraging regional economic integration through the operation of a common regional market

The Western Balkans region is facing major economic problems because it is not sufficiently attractive to investors due to small fragmented markets as well as high emigration rates, which are the result, as stated in the Plan, of the limited options offered to citizens.

The development of a Common Regional Market is important for two reasons. The first reason is to take advantage of the economic potential of the region, opening opportunities for local companies and workers in order to make the Western Balkans more attractive to european investors. Another reason is that the Common Regional Market represents an important step towards the single market of the European Union in many areas.

The EU will provide numerous opportunities for integration into the EU single market only if the region achieves regional economic integration, and the benefits of the Growth Plan can only be expected by countries that are committed to the Common Regional Market [17, pp.6-8].

The third pillar - Acceleration of fundamental reforms

Better integration with the single market of the European Union and targeted financial support are not enough to accelerate

socioeconomic convergence. They are important for candidate countries to progress on their path to EU membership and for their economies to cope with the pressures of a competitive single market, as well as for building competitive and sustainable businesses to attract private investment. Accelerating fundamental reforms will simultaneously speed up the process of accession of countries to the European Union.

As part of the growth plan, each partner from the Western Balkans is obliged to draw up a program of reforms. The reform program will determine a limited set of priority reforms, broken down into qualitative and quantitative steps. Those steps will serve as payment conditions, that is, after the completion of each step, funds from the new instrument for reforms and growth will be allocated in accordance with pre-determined deadlines.

Payment conditions will be linked to specific socioeconomic reforms to realize national and regional potential for growth, as well as specific reforms related to fundamental issues of the enlargement process, including the rule of law, democracy and respect for human rights and fundamental freedoms. The reform program will be a key element of the growth plan, and its implementation will be a mandatory prerequisite for fully exploiting the advantages offered by the single market, obtaining funds from the new instrument for reforms and growth, as well as for bringing countries closer to meeting the criteria for membership in the Union [17, p.8].

Fourth pillar - Encouraging convergence by increasing financial assistance: a new instrument for reforms and growth for the Western Balkans

The new Reform and Growth Instrument for the Western Balkans is crucial in implementing the new Growth Plan thanks to increased financial assistance. The proposed instrument will cover the period from 2024 to 2027. Financial support from the Instrument will be provided in the form of grants (in the amount of up to 2 billion euros) and loans (in the amount of up to 4 billion euros) through direct payments to national budgets or as financing of capital investments through the Investment Framework in the Western Balkans.

It will be the central instrument of the growth plan, which will significantly increase financial assistance based on an ambitious reform plan focusing on necessary socioeconomic reforms combined with fundamental reforms related to the rule of law and fundamental rights.

The disbursement of funds will be strictly conditional on the implementation of key reforms, taking into account the recommendations from the Commission's latest enlargement package. The financial effect of the instrument will enable the Western Balkans to receive approximately the same amount of support and aid per inhabitant as the EU within the cohesion policy.

In this way, the increasingly strong need of the region for stronger socioeconomic convergence would be answered, the region would be shown the benefits of integration in the European Union even before accession. The long-term goal is to help the Western Balkan region achieve its full potential by 2030 in terms of capacity for economic and social development in relation to the member states of the European Union [17, pp.8-9].

BENEFITS FOR CITIZENS FROM THE GROWTH PLAN FOR THE WESTERN BALKANS

In July 2025, the European Commission notified Bosnia and Herzegovina of a 10% reduction in the amount of funds under the Growth Plan due to delays in sending the Reform Agenda. Bosnia and Herzegovina is now eligible for up to 976.6 million euros instead of 1.085 billion. The Council of Ministers of Bosnia and Herzegovina managed to send the finalized Reform Agenda to the European Commission in October 2025, which will enable the receipt of significant investments under the Growth Plan. Other countries in the Western Balkans region submitted their reform agendas as early as 2024. The Reform Agenda is a document containing a set of measures that a country must implement in order to meet the standards and conditions set by the European Union for the allocation of financial resources.

Through the Reform Agenda, which forms a central part of the EU Growth Plan for the Western Balkans, the countries of the

region have the opportunity to accelerate reforms and social and economic convergence with the European Union. In response to the challenges of global warming and climate change, which do not bypass the Western Balkans region, significant changes are taking place in the energy sector at the European Union level, which are most often described as the energy transition. It is about the gradual elimination of coal as the main source of energy and the transition to cleaner and renewable energy sources, which requires changes in energy production technology, but also in energy transformation, distribution and consumption.

Decarbonization is necessary to meet the obligations in terms of reducing harmful gas emissions, seize the opportunity for greener growth, reduce environmental pollution and improve energy security in the region.

The green transition offers an opportunity to address some of the challenges posed by climate change and to achieve benefits such as transforming the energy sector in line with European rules, integrating the Western Balkans energy market with the single European market, and ensuring affordable electricity prices in order to protect consumers and reduce energy poverty.

Promoting digital connectivity leads to the improvement of broad communications infrastructure, such as 5G networks, providing access to very fast internet, which is crucial to supporting digital services and applications. This can bridge the digital divide, providing equal opportunities for development for all countries in the region and greater social inclusion, given that digital skills training ensures that more people can fully participate in the digital society, access information, digital services and online opportunities.

Citizens of the Western Balkan countries are the ones who will benefit the most from the Plan itself, as it includes, among other things, investments in roads, cheaper energy, and better and faster internet.

CONCLUSION

Integration with the single market of the European Union has been the main driver of economic growth for all countries that have acceded to the Union. Financial support to the

Western Balkans region is conditional on the implementation of the activities foreseen by the reform measures. In order to meet the condition for the allocation of funds under the Growth Plan, the countries of the Western Balkan region are expected to harmonize their reform plans with the European Union, that is, to prepare and adopt the Reform Agenda for the EU Instrument for Reforms and Growth. This document should contain a list of reform measures with detailed activities to take advantage of the European Union incentives available through the Instrument for Reform and Growth for the Western Balkans, in order to implement key reforms in areas of strategic importance for accelerating economic growth.

Milica Uvalić, in her analysis of the Growth Plan for the Western Balkans, notes that cooperation is extremely important among the Western Balkans countries, boosting regional economic integration [19, p.8].

The objective of the Growth Plan for the Western Balkans is to bring the benefits of membership in the European Union to the region of the Western Balkans prior to accession, to strengthen economic growth and accelerate socio-economic rapprochement. The goal is to enable partner countries to intensify reforms and investments in order to significantly accelerate the process of expansion and growth of their economies. For this purpose, a new Instrument for Reforms and Growth for the Western Balkans worth 6 billion euros has been proposed for the period from 2024-2027. Payments will be made only when the agreed reforms are implemented.

Through reforms and financial investments by the European Union, the Plan will enable the Western Balkans to soon feel the benefits in the areas of the single market, including the freedom of movement of goods, services and workers, the single payment area in euros, and everything from energy, transport and the single digital market. "In the future, full liberalization of tariffs for products and services and the reduction of nontariff barriers would be crucial not only to boost regional trade but, most importantly, to increase Western Balkan exports to the EU market and beyond" [20, p.9].

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURE

1. Allocations available for each beneficiary - Growth Plan for the Western Balkans, pristupljeno 20.06.2025 https://enlargement.ec.europa.eu/enlargement-policy/growth-plan-western-balkans/allocations-available-each-beneficiary_en
2. Đukanović, D. (2015). Zapadni Balkan: Stalni sud evropske periferije. *Međunarodni problemi*, 67(4), 349-364.
3. Jovanović, M. (2015). Zapadni Balkan i EU: obrnuti perspektivu. *Međunarodna politika*, 66(1158-1159), 37-51.
4. Nakić, M. (2013). Europska unija i Zapadni Balkan-između želja i realnosti. *Međunarodne studije*, 13(1), 33-44.
5. Lopandić, D. (2007). *Reforma Evropske unije, Zapadni Balkan i Srbija – zakasnela integracija*. Beograd: Evropski centar za mir i razvoj (ECPD).
6. Yariş, Z. B. (2024). The challenges of "renewed" enlargement to the Western Balkan countries. *Studia Europejskie*, 28(3), 125-141.
7. Teokarević, J. (2016). Skroman napredak ka sve manje poželjnoj EU: Zapadni balkan u evropskim integracijama 2015-16. godine. In M. Simurdić (Ur.), *Spoljnopolitičke sveske 1/2016, Zapadni Balkan između geografije i geopolitike* (str. 7-16). Beograd: Fondacija Fridrih Ebert i : Evropski pokret u Srbiji - Forum za međunarodne odnose.
8. Accession criteria - Copenhagen criteria. (1993). Pristupljeno 15.06.2025. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=legissum:accession_criteria_copenhagen
9. Butković, H., & Samardžija, V. (2014). Challenges of continued EU enlargement to the Western Balkans-Croatia's experience. *Economics and Business Review*, 14(4), 91-108.
10. Miljanović, R. i Kukulj, S. (2023). *Program ekonomskih reformi – 10 godina kasnije*. Beograd: Centar za evropske politike.

Đurić Džakić, M (2025). The european union growth plan for the Western Balkans as a form of faster integration into the EU single market. *STED Journal*, 7(2), 66-73.

11. Milovanović, J. (2017). Zapadni Balkan u Evropskoj uniji-izazovi i rizici u procesu pristupanja. *Vojno delo*, 69(1), 42-53.
12. Minić, J. (2016). Budućnost EU i Zapadni Balkan – Pogled iz Srbije. In J. Minić (Ur.), *Spoljnopolitičke sveske 3/2016, Budućnost EU i Zapadni Balkan – Pogled iz Srbije* (str. 5-12). Beograd: Fondacija Fridrih Ebert I Evropski pokret u Srbiji - Forum za međunarodne odnose.
13. Filipović, S., & Ignjatović, J. (2022). Ekonomski razvoj Zapadnog Balkana: Šanse i ograničenja za zelenu tranziciju. *Megatrend revija*, 19(3), 167-182.
14. Sotiroski, L. (2016). The EU Strategy for Supporting Western Balkans Enlargement Process. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 25(1), 278-296.
15. Stabilisation and Association Agreement between the European Communities and their Member States and Bosnia and Herzegovina. (2015). [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:22015A0630\(01\)](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:22015A0630(01))
16. Dimitrijević, D. (2025). The Challenges and Prospects of the Development and Modernisation of the Western Balkan Countries in the Process of European Integration. In F. Zhongping, & H. Mengmeng, (Eds.), *European Security Order, Integration and Modernisation - Perspectives and Challenges in the Central and Eastern European Region* (pp.327-367). Budapest: CHINA–CEE Institute.
17. European Commission. (2023). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions - New growth plan for the Western Balkans*. Brussels: European Commission. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0691>
18. European Union (2024). Regulation 2024/1449 of the European Parliament and of the Council of 14 May 2024 on establishing the Reform and Growth Facility for the Western Balkans. <http://data.europa.eu/eli/reg/2024/1449/oj>
19. Uvalić, M. (2024). *The potential of the New Growth Plan for the Western Balkans*. Florence: European University Institute.
20. Zeneli, V., Grieveson, R., Ioannides, I., & Bechev, D. (2025). *The European Union Growth Plan for the Western Balkans: A reality test for EU enlargement*. Washington: The Atlantic Council of the United States.

NEGATIVAN UTICAJ CHATGPT-A NA OBRAZOVANJE

Vesna Simikić, Veljko Aleksić

¹Univerzitet u Kragujevcu, Fakultet tehničkih nauka, Svetog Save 65, Čačak, Srbija,
simikic.vesna.85@gmail.com, veljko.aleksic@ftn.kg.ac.rs

PREGLEDNI NAUČNI RAD

ISSN 2637-2150
e-ISSN 2637-2614
DOI 10.63395/STEDJournal0702089S74
UDC 004.738.5:004.89
COBISS.RS-ID 143561217

Received: 14 October 2025.

Revised: 03 November 2025.

Accepted: 04 November 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Korespondentni autor: Vesna Simikić,
Fakultet tehničkih nauka, Svetog Save 65,
Čačak, Srbija, simikic.vesna.85@gmail.com



Copyright © 2025 Vesna Simikić i
Veljko Aleksić; published by UNIVERSITY
PIM. This work licensed under the Creative
Commons Attribution-NonCommercial-
NoDerivs 4.

Citation: Simikić, V. & Aleksić, V. (2025).
Negativan uticaj ChatGPT-a na obrazovanje.
STED Journal, 7(2), 74-82.
<https://doi.org/10.63395/STEDJournal0702089S74>

SAŽETAK

Uvođenje generativnih jezičkih modela poput ChatGPT-a u obrazovni sistem donosi brojne benefite, ali i značajne izazove koji mogu negativno uticati na kvalitet obrazovanja. Analiza relevantne naučne literature na primjeru korištenja vještačke inteligencije u obrazovanju pokazuje da prekomjerna upotreba može dovesti do pasivnog pristupa učenju, smanjenja motivacije za samostalno razmišljanje i razvoja kognitivnih sposobnosti, te povećanja rizika od akademskog nepoštenja. Poseban

izazov predstavlja i uticaj na kompetencije pa se kod studenata bilježi površno razumijevanje programiranja i algoritamskog razmišljanja usljed oslanjanja na gotova rješenja. Rad ističe potrebu za razvijanjem jasnih pedagoških i etičkih okvira koji bi usmjeravali odgovornu i kritičku upotrebu alata vještačke inteligencije u obrazovanju. U tom smislu, preporučuje se integracija AI pismenosti u kurikulum, redizajn evaluacija na višim nivoima Blumove taksonomije, te osnaživanje nastavnika za vođenje učenika kroz aktivne misaone procese. Balansiran i promišljen pristup može omogućiti optimalno korištenje prednosti ChatGPT-a, uz očuvanje kvaliteta i integriteta obrazovnog procesa, posebno u oblasti informacionih tehnologija.

Cljučne riječi: ChatGPT, vještačka inteligencija, obrazovanje, informacione tehnologije

UVOD

Uvođenje vještačke inteligencije (AI) u obrazovni sistem predstavlja jednu od najznačajnijih transformacija savremenog doba. ChatGPT je tehnologija koja ubrzano mijenja način na koji učenici i studenti pristupaju znanju, učenju i akademskim obavezama omogućavajući automatizaciju zadataka, brži pristup informacijama i personalizovano učenje. Pored svih prednosti koje sa sobom nosi, upotreba vještačke inteligencije u obrazovanju ima i mračnu stranu. Kritičari upozoravaju da se olakšan pristup rješenjima može odraziti na smanjenje motivacije za samostalno razmišljanje i rješavanje problema, što dovodi u pitanje razvoj kognitivnih sposobnosti i sposobnosti kritičkog mišljenja kod učenika.

Otvoraju se i brojna pitanja u vezi s akademskom čestitošću, budući da mnogi studenti koriste alate vještačke inteligencije za izradu zadataka i eseja, često bez jasnog razumijevanja etičkih implikacija. Nejasnoće u institucionalnim pravilima i normama dodatno

komplikuju razgraničenje između dozvoljene i nedozvoljene upotrebe ovih alata. Kao rezultat toga dolazi do porasta potreba za jasnim pedagoškim okvirima koji će usmjeravati upotrebu vještačke inteligencije u obrazovanju. Integracija vještačke inteligencije u obrazovne procese ne smije biti posmatrana isključivo kao izazov, nego i kao kompleksan društveni i pedagoški fenomen. Potrebno je razvijati pristupe koji ne samo da iskorištavaju prednosti, već i aktivno rade na očuvanju integriteta obrazovanja. U tom kontekstu, posebno je važno istražiti ravnotežu između koristi i rizika koje vještačka inteligencija donosi u obrazovni sistem.

Cilj istraživanja

Cilj rada je sistematična analiza negativnih posljedica korištenja ChatGPT-a u obrazovanju, sa osvrtom na relevantnu naučnu literaturu iz perioda 2024–2025. godine. Iz ugla informacionih tehnologija i primjene vještačke inteligencije fokus će biti na:

- Promjeni načina učenja i sticanja znanja;
- Etici i akademskoj čestitosti;
- Tehničkim ograničenjima i „halucinacijama“ modela;
- Mogućoj zavisnosti korisnika od alata vještačke inteligencije;
- Uticaju na kompetencije iz IT oblasti, kao što su kodiranje, rješavanje problema i algoritamsko razmišljanje.

METODOLOGIJA

Rad koristi kvalitativnu analizu sekundarnih izvora, odnosno sistematski pregled relevantne naučne literature iz perioda 2024–2025. godine. Korišćeni su naučni članci iz baza podataka kao što su IEEE Xplore, Springer, MDPI, SAGE, arXiv, Elsevier i Frontiers. Posebna pažnja posvećena je studijama koje se bave empirijskim istraživanjima uticaja generativnih AI alata na obrazovni proces u kontekstu informacionih tehnologija.

Pregled literature

Upotreba generativnih jezičkih modela poput ChatGPT-a donosi značajne prednosti u obrazovanju, posebno kad je riječ o personalizaciji nastave i bržem pristupu informacijama. Hassen (2025) pokazuje da AI

alati mogu poboljšati sposobnosti učenika u čitanju, rješavanju problema i u određenim slučajevima pisanja, ali naglašava da se često javlja „kognitivna atrofija“ ako se učenici previše oslanjaju na AI kao „motor rješenja“ [1]. Takođe, Akbar (2025) u svom radu upozorava da zadaci koji zahtijevaju samo ponavljanje ili sažimanje činjenica (niski nivo Bluma³) olakšavaju zloupotrebu AI-alata i ne zahtijevaju stvaran angažman učenika [2].

Međutim, ovi modeli koriste se i na način koji može umanjiti razvoj kritičkog mišljenja i samostalnog argumentovanja. Nasr i drugi (2025) istražuju razliku između pasivne upotrebe ChatGPT-a, gdje vještačka inteligencija sama kreira sadržaj, i saradnju čovjeka i vještačke inteligencije, i nalaze da pasivna upotreba značajno smanjuje angažman učenika u kritičkom preispitivanju informacija [3]. U kontekstu akademske čestitosti, studije pokazuju da studente često zbunjuju institucionalne politike, a etičke norme igraju veću ulogu u predviđanju stvarnog ponašanja od same svijesti o pravilima. Lund i drugi (2025) u svojoj studiji o percepcijama studenata pokazuju da su etički stavovi ključni za predviđanje načina na koji će studenti procijeniti korištenje alata vještačke inteligencije u pisanju zadataka [4]. Da bi se negativni efekti umanjili, sugerišu se promjene u dizajnu nastave i obrazovnim politikama. Akbar (2025) preporučuje usmjeravanje na zadatke višeg nivoa u Blumovoj taksonomiji – analizu, evaluaciju, kreaciju, koji su „otporni“ na automatizaciju i po kojima je znatno lakše razlikovati originalni rad od rada koji je generisan od strane vještačke inteligencije [2]. Tan i Maravilla (2024) razmatraju kako generativna AI ne mora nužno narušiti integritet obrazovanja ukoliko se ona etički integriše, podržavajući motivaciju učenika koja potiče od želje da se nešto radi zbog užitka, interesovanja ili lične satisfakcije, uz razvijanje digitalne pismenosti [5]. Melisa i drugi (2025) u svom sistematskom pregledu ukazuju na važnost podržavanja nezavisnog mišljenja učenika [6].

³Blumova taksonomija je hijerarhijska klasifikacija nivoa učenja i vaspitanja, podeljena na tri domena: kognitivni (znanja i intelektualne vještine), afektivni (stavovi i vrijednosti) i psihomotorni (fizičke i perceptivne vještine).

Wang i Fan (2025) upozoravaju na rizike plagijata, akademskog nepoštenja i smanjenja motivacije za samostalno učenje usled prekomjerne upotrebe ChatGPT-a [7]. Springerova studija (2024) dodatno potvrđuje porast plagijarizma i smanjenje autentičnosti studentskih radova, naročito kod eseja i tehničkih izvještaja [8]. Ovi fenomeni narušavaju integritet obrazovnog procesa i zahtijevaju hitnu reakciju obrazovnih institucija. Bez adekvatnih smjernica i edukacije, studenti rizikuju gubitak ključnih akademskih vrijednosti.

Zhang i Tur (2024) ističu smanjenje kvaliteta interakcije između učenika i nastavnika, kao i mogućnost širenja netačnih informacija putem generativnih AI alata [9]. Weeks i drugi (2024) u svojim istraživanjima pokazuju da studenti koji ih koriste često imaju površno razumijevanje koncepta, što negativno utiče na njihove rezultate [10]. Kanbul i drugi (2024) upozoravaju da bez odgovarajuće regulative, masovno usvajanje AI alata može dugoročno urušiti obrazovne standarde, posebno u STEM⁴ oblastima. Takva situacija zahtijeva integrisani pristup koji uključuje tehnološke, pedagoške i etičke mjere [11].

Pored akademskih problema Abdallah i drugi (2025) povezuju prekomjernu upotrebu ChatGPT-a sa povećanim stresom kod učenika, smanjenom psihološkom dobrobiti i lošijim akademskim ishodima [12]. Davar i drugi (2025) takođe ističu negativan uticaj na razvoj algoritamskog mišljenja jer učenici često koriste vještačku inteligenciju bez pokušaja samostalnog rješavanja zadataka [13]. Istraživanja naglašavaju važnost promišljenog uključivanja alata vještačke inteligencije u obrazovni proces, uz podršku mentora i kontinuiranu evaluaciju, jer je cilj očuvanje kvaliteta učenja i razvoja ključnih kognitivnih vještina kod učenika.

Teorijski okvir

U savremenom obrazovanju sve veći uticaj imaju generativni AI alati poput

ChatGPT-a, koji mijenjaju način na koji učenici pristupaju znanju i obavezama. Ovaj rad se temelji na konstruktivističkoj teoriji učenja, prema kojoj je aktivno učešće učenika ključno za kvalitetan obrazovni proces. Takođe ukazuje na važnost konteksta i interakcije u izgradnji znanja, što podrazumijeva angažman, refleksiju i samostalno zaključivanje [14]. Međutim, automatizacija odgovora putem alata vještačke inteligencije podstiče pasivno preuzimanje gotovih informacija, čime se smanjuje prostor za razvoj dubljeg razumijevanja [15].

Korištenje AI modela poput ChatGPT-a može se dodatno analizirati kroz teoriju kognitivnog opterećenja, prema kojoj balans između obrade informacija i kognitivnih kapaciteta ima veoma važnu ulogu u učenju. ChatGPT može pomoći učenicima u privremenom smanjivanju kognitivnog napora, npr. kroz sažimanje složenih tekstova ili automatizaciju pisanja. Međutim, previše povjerenja u alate vještačke inteligencije može dovesti do znatno slabijeg usvajanja znanja i smanjenja sposobnosti za rješavanje problema. Time se narušava proces automatizacije znanja koji je ključan za razvoj stručnosti [1].

Važan aspekt upotrebe vještačke inteligencije u obrazovanju predstavlja etička dimenzija u pogledu akademske čestitosti. Generativni AI alati postavljaju pitanja o autorstvu, odgovornosti i granicama dozvoljene pomoći u obrazovnom kontekstu. Studenti često nisu dovoljno upućeni u institucionalna pravila o korišćenju ovih alata, što dovodi do konfuzije i potencijalnih slučajeva plagijarizma [16]. Zbog toga je vrlo važna uloga etike u informacionim tehnologijama kao sastavnog dijela obrazovne politike i digitalne pismenosti [13].

Fenomen tehnostresa (engl. technostress) postaje sve prisutniji među studentima, što je potvrđeno nedavno [17]. Učestalo korištenje digitalnih alata, uključujući AI, može izazvati osjećaj preopterećenosti, kognitivne iscrpljenosti i emocionalne disonance [3]. Takva stanja negativno utiču na psihološko blagostanje, motivaciju za učenje i opštu akademsku uspješnost. Uvođenje AI tehnologija mora se, stoga, pratiti i sa aspekta mentalnog zdravlja korisnika [12].

⁴STEM je akronim za nauku, tehnologiju, inženjerstvo i matematiku, a odnosi se na oblasti obrazovanja i karijere koje se oslanjaju na ove discipline, a cilj je da se one uče zajedno, povezujući teoriju sa rješavanjem realnih problema.

Shvatanje tehnologije kao pokretača promjena u načinu učenja i društvenom životu otvara prostor za dublje analize obrazovnih i društvenih praksi. U skladu sa time ChatGPT se ne može posmatrati kao neutralni alat jer aktivno oblikuje načine mišljenja, interakcije i evaluacije u obrazovnom kontekstu [5]. Takav uticaj zahtijeva kritičku refleksiju o ulozi tehnologije u obrazovanju, uz uključivanje šire društvene i pedagoške perspektive. Održavanje ravnoteže između tehnološke funkcionalnosti i obrazovnih vrijednosti ključno je za osiguranje kvaliteta i integriteta obrazovnog procesa.

REZULTATI

U okviru ovog rada identifikovano je ukupno 21 relevantna naučna publikacija iz perioda 2024–2025. godine koje se bave negativnim aspektima korišćenja ChatGPT-a i srodnih generativnih AI alata u obrazovanju. Radovi su preuzeti iz renomiranih izvora, uključujući naučne baze podataka kao što su IEEE Xplore, Springer, MDPI, SAGE, arXiv, Elsevier i Frontiers. U analizu su uključeni sistematski pregledi, empirijske studije, meta-analize i konceptualni radovi, koji pokrivaju različite obrazovne nivoe – od osnovnog do visokog obrazovanja. Radovi analiziraju uticaj ChatGPT-a na aspekte poput kritičkog mišljenja, akademske čestitosti, kreativnosti, psihološkog blagostanja, percepcije učenja i stresa kod studenata.

Sve veća dostupnost i integracija ChatGPT-a u obrazovne procese dovela je do značajnih promjena u načinima učenja i usvajanja znanja. Analiza aktuelnih studija pokazuje da učenici često koriste ovaj alat za rješavanje domaćih zadataka, pisanje radova i odgovaranje na testove [13]. Takva praksa vodi ka površnom savladavanju gradiva i slabijoj sposobnosti dugoročnog pamćenja i primjene znanja. S obzirom na brzinu i tačnost odgovora koje nudi vještačka inteligencija, učenici sve češće biraju pasivne pristupe učenju, umjesto angažovanog istraživanja i analize literature. Prekomjerna upotreba ChatGPT-a direktno utiče na pad sposobnosti samostalnog mišljenja i logičkog zaključivanja. Studenti koji poklanjaju povjerenje AI alatima u cilju izrade rješenja za

tehničke zadatke, poput programiranja, pokazuju nižu efikasnost u razumijevanju strukture koda [10]. Osim toga, učestala oslanjanja na „gotova rješenja” smanjuju interes za dublje istraživanje problema i razvoj analitičkih vještina [2]. Time se potiskuju osnovne kompetencije koje su ključne za profesionalni razvoj, posebno u domenima informacionih tehnologija [6].

Jedan od najizraženijih problema jeste porast akademskog nepoštenja i plagijata, što potvrđuju i nedavne studije [13]. ChatGPT omogućava generisanje tekstova koji izgledaju autentično, ali se često preuzimaju bez izmjena, čime se gubi autorska odgovornost. Takav pristup vodi ka stvaranju obrazovne kulture u kojoj se originalnost i trud potiskuju u korist brzih i lako dostupnih rješenja [16]. Erozijski etičkih normi u tom kontekstu nije samo individualni, već i sistemski izazov [14]. Dodatni problem čini pojava dezinformacija i tzv. halucinacija u AI generisanom sadržaju, gdje ChatGPT može kreirati netačne ili nepostojeće informacije. Ovo je posebno opasno u obrazovnom kontekstu jer može stvoriti lažno uvjerenje o tačnosti određenih pojmova, teorija ili algoritama. Učenici koji nisu dovoljno informatički pismeni mogu teško prepoznati takve greške, čime se povećava rizik od stvaranja „pogrešnog znanja” [7]. Time se smanjuje motivacija za dubljim razumijevanjem i provjerom izvora, što dodatno slabi akademski integritet [6].

Kako bi se ovi izazovi ublažili, neophodno je uvesti više dimenzija u pedagoški pristup upotrebi vještačke inteligencije. Preporučuje se uključivanje AI pismenosti u IT kurikulum, gdje bi studenti učili kako odgovorno i kritički koristiti ove alate [7]. Takođe, evaluacije bi trebalo da budu redizajnirane tako da uključuju praktične, timske i problemski orijentisane zadatke koji smanjuju mogućnost zloupotrebe generativne vještačke inteligencije. Takođe, važno je raditi na jačanju svijesti o etici, akademskoj čestitosti i važnosti vlastitog razmišljanja, čime se dugoročno jačaju i kognitivne i moralne kompetencije učenika [13].

DISKUSIJA

Istraživanja ukazuju na neophodnost osmišljenog i balansirano pristupa primjeni ChatGPT-a u obrazovanju. Nedovoljna edukacija nastavnika o funkcionalnostima AI alata i izostanak jasnih etičkih okvira doprinose njihovoj neadekvatnoj upotrebi, posebno u kontekstu razvoja viših kognitivnih i socijalnih vještina [10]. Iako ChatGPT može podržati individualizirano učenje i brži pristup znanju, pretjerano oslanjanje na AI ugrožava intelektualnu autonomiju učenika. Posebno je ugrožen razvoj kritičkog mišljenja, koji zahtijeva dubinsku obradu informacija, a ne automatski generisane odgovore [6].

U obrazovanju iz oblasti informacionih tehnologija, izazovi postaju još izraženiji. Usljed dostupnosti rješenja koja nudi ChatGPT, studenti se oslanjaju na ovaj alat umjesto da razvijaju vlastite algoritme, čime slabe vještine programiranja, analitičkog mišljenja i kreativnog rješavanja problema [1]. Ova praksa može dugoročno dovesti do stvaranja generacija IT stručnjaka sa površnim znanjem i slabom profesionalnom kompetencijom. Alati vještačke inteligencije često ne prepoznaju lokalne kurikulume, tehničke standarde i kontekstualne zahtjeve nastave [11], što smanjuje relevantnost generisanog sadržaja [6].

Institucije visokoškolskog obrazovanja sve češće razvijaju sveobuhvatne politike za integraciju alata vještačke inteligencije u nastavu i učenje. Na primjer, studije ističu da mnoge institucije, posebno u azijskom kontekstu, uvode ograničenja u upotrebi generativnih alata za akademske zadatke, dok istovremeno prepoznaju potrebu za razvojem smjernica o njihovoj odgovornoj i etičkoj upotrebi [18]. Takav institucionalni odgovor – izrada okvira koji obuhvata pedagošku, upravljačku i operativnu dimenziju – omogućava smanjenje rizika zloupotrebe AI alata i jačanje njihove integracije u obrazovni proces, uz jačanje povjerenja i kompetencija svih učesnika u obrazovanju [19].

Kurikularni pristupi pokazali su se ključnim za adaptaciju nastavnika i studenata na nove tehnologije AI, pri čemu su radionice, profesionalni razvoj i revizija nastavnih planova važni instrumenti. Primjeri iz evropskog i latinoameričkog konteksta

pokazuju da su pojedine institucije uvele specijalizovane module i obuke kojima se nastavnici osposobljavaju za kritičko razumijevanje i praktičnu primjenu generativnih alata u učenju i poučavanju [20]. Takvi kurikularni odgovori pomažu ne samo u tehničkoj implementaciji tehnologije, nego i u izgradnji kompetencija za etičku, reflektivnu i učinkovitu upotrebu AI – što je naročito važno imajući u vidu izazove koji se odnose na akademski integritet, pristranost algoritama i pravičan pristup učenju [21].

Poseban naglasak institucionalnih strategija usmjeren je na etičke i upravljačke aspekte primjene AI u obrazovanju, što uključuje izradu smjernica, razvoj regulative i mehanizama nadzora. Analize evropskih i međunarodnih obrazovnih politika ukazuju na to da se postojeći pristupi uglavnom fokusiraju na četiri ključne ciljne grupe – studente, nastavnike, obrazovne menadžere i kreatore politika – pri čemu su prisutne značajne praznine koje zahtijevaju sistemsko popunjavanje [19]. U praksi, institucije mogu postaviti jasne propise o upotrebi generativnih alata, razviti mehanizme za otkrivanje zloupotrebe te kontinuirano pratiti i evaluirati implementaciju, čime se obezbjeđuje transparentnost, odgovornost i inkluzivnost u procesu primjene AI u obrazovanju [21].

Etika predstavlja ključni aspekt primjene vještačke inteligencije u obrazovanju, posebno kada je riječ o očuvanju akademske čestitosti. Upotreba generativnih AI alata otvara niz pitanja koja se odnose na autorstvo, odgovornost i granice dozvoljene pomoći u obrazovnom procesu. Nejasnoće u vezi s ovim pitanjima često dovode studente u situacije u kojima nesvjesno krše pravila akademskog ponašanja. Nedostatak jasnog razumijevanja institucionalnih pravila može dovesti do konfuzije i pojave plagijarizma [16]. Neophodno je etičku dimenziju integrisati u obrazovne politike i programe digitalne pismenosti [4]. Etika u informacionim tehnologijama mora biti sastavni dio edukacije, kako bi se studenti osposobili za odgovornu i savjesnu upotrebu AI alata. Obrazovni sistemi treba da razviju jasne smjernice koje će regulisati upotrebu vještačke inteligencije u akademskom kontekstu [4]. Time se doprinosi očuvanju

integriteta obrazovanja i razvoju tehnološki i etički kompetentnih pojedinaca [13].

U cilju efektivnije integracije vještačke inteligencije u obrazovanje, neophodno je razviti nove pedagoške modele kao asistivni, a ne zamjenski alat [14]. U obrazovne kurikule sistematski treba uvoditi AI pismenost, kako bi studenti razvili svijest o potencijalima i rizicima ovih tehnologija. Takođe, nastavnici moraju biti osnaženi da kritički koriste vještačku inteligenciju u nastavi, uz naglasak na podsticanje misaonih procesa i refleksije kod učenika [13]. Tako je moguće koristiti prednosti vještačke inteligencije i zaštititi integritet i kvalitet obrazovanja.

ZAKLJUČAK

Primjena ChatGPT-a u obrazovnom kontekstu predstavlja kompleksan izazov koji zahtijeva pažljivu analizu i promišljeno uvođenje u nastavni proces. Neograničeno i neadekvatno korištenje ovog alata može negativno uticati na razvoj ključnih vještina učenika, uključujući samostalnost u učenju, kritičko mišljenje i socijalne kompetencije. Osim toga, upotreba generativne vještačke inteligencije bez jasnih pravila može narušiti akademski integritet i podstaći neetične obrazovne prakse. Zbog toga je veoma važno definisati jasne smjernice i pravila za upotrebu AI alata u obrazovanju.

Posebnu pažnju treba posvetiti integraciji ChatGPT-a u oblasti informacionih tehnologija, gdje postoji visok rizik od smanjenja sposobnosti studenata da rješavaju složene probleme. Iako vještačka inteligencija može značajno unaprijediti proces učenja kroz personalizaciju i efikasniju dostupnost informacija, prekomjerna upotreba može rezultovati stvaranjem površnog znanja i gubitkom motivacije kod studenata. Takvi efekti posebno dolaze do izražaja u tehničkim disciplinama koje zahtijevaju dubinsko razumijevanje, analitičko razmišljanje i aktivno učenje. Zato je važno osigurati ravnotežu između podrške koju nudi vještačka inteligencija kroz veliki broj svojih alata i očuvanja kognitivnih procesa bitnih za profesionalni razvoj.

U svrhu obezbjeđivanja odgovorne upotrebe generativne vještačke inteligencije u

obrazovanju, neophodno je da obrazovne institucije, istraživači i stručnjaci iz IT sektora djeluju zajednički. Zbog toga je ključan razvoj strategija koje će, pored regulacije upotrebe ChatGPT-a, imati za zadatak promociju etičkih i kritičkih aspekata same integracije AI alata u obrazovanje. Takve strategije trebaju biti zasnovane na dokazima iz istraživanja, kao i na kontinuiranoj evaluaciji efekata primjene alata vještačke inteligencije u nastavnom procesu, kako bi se smanjili rizici i povećale obrazovne koristi. Dugoročni cilj mora biti stvaranje obrazovnog okruženja koje koristi potencijal vještačke inteligencije kao dodatak tradicionalnim metodama učenja, a ne kao njihovu zamjenu. Edukacija nastavnika i učenika o prednostima i ograničenjima tehnologija vještačke inteligencije predstavlja ključni korak ka njihovom odgovornom korištenju.

Podsticanjem razvoja kompetencija poput digitalne pismenosti, etičkog rasuđivanja i kreativnog mišljenja, koje su ključne u eri sveprisutne AI tehnologije, moguće je oblikovati obrazovni sistem koji je istovremeno tehnološki napredan i pedagoški odgovoran, te usmjeren ka razvoju vještina koje su ključne za snalaženje u savremenom digitalnom društvu. Time se stvaraju uslovi za održiv i kvalitetan razvoj obrazovanja u skladu sa zahtjevima budućnosti.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURA

1. Hassen, M. Z. (2025). The Impact of AI on Students' Reading, Critical Thinking, and Problem-Solving Skills. *American Journal of Education*, 9(2), 82-90.
<https://doi.org/10.11648/j.ajeit.20250902.12>
2. Akbar, M. S. (2025). Beyond Detection: Designing AI-Resilient Assessments with Automated Feedback Tool to Foster Critical Thinking. *arXiv preprint arXiv:2503.23622*.
<https://doi.org/10.48550/arXiv.2503.23622>

Simikić, V. & Aleksić, V. (2025). Negativan uticaj ChatGPT-a na obrazovanje. *STED Journal*, 7(2), 74-82.

3. Nasr, N. R., Tu, C. H., Werner, J., Bauer, T., Yen, C. J., & Sujo-Montes, L. (2025). Exploring the Impact of Generative AI ChatGPT on Critical Thinking in Higher Education: Passive AI-Directed Use or Human-AI Supported Collaboration? *Education Sciences*, 15(9), 1198. <https://doi.org/10.3390/educsci15091198>
4. Lund, B., Mannuru, N.R., Teel, Z.A., Lee, T.H., Ortega, N.J., Simmons, S., & Ward, E. (2025). Student Perceptions of AI-Assisted Writing and Academic Integrity: Ethical Concerns, Academic Misconduct, and Use of Generative AI in Higher Education. *AI in Education*, 1(1), 2. <https://doi.org/10.3390/aieduc1010002>
5. Tan, M.J.T., & Maravilla, N.M.A.T. (2024). Shaping integrity: why generative artificial intelligence does not have to undermine education. *Frontiers in artificial intelligence*, 7, 1471224. <https://doi.org/10.48550/arXiv.2407.19088>
6. Melisa, R., Ashadi, A., Triastuti, A., Hidayati, S., Salido, A., Luansi Ero, P. E., Marlini, C., Zefrin, Z., & Al Fuad, Z. (2025). Critical Thinking in the Age of AI: A Systematic Review of AI's Effects on Higher Education. *Educational Process: International Journal*, 14, e2025031. <https://doi.org/10.22521/edupij.2025.14.31>
7. Wang, J., & Fan, W. (2025). The effect of ChatGPT on students' learning performance, learning perception, and higher-order thinking: insights from a meta-analysis. *Humanities and Social Sciences Communications*, 12(1), 1-21. <https://doi.org/10.1057/s41599-025-04787-y>
8. Yusuf, A., Pervin, N., & Román-González, M. (2024). Generative AI and the future of higher education: a threat to academic integrity or reformation? Evidence from multicultural perspectives. *International Journal of Educational Technology in Higher Education*, 21(1), 21. <https://doi.org/10.1186/s41239-024-00453-6>
9. Zhang, P., & Tur, G. (2024). A systematic review of ChatGPT use in K-12 education. *European Journal of Education*, 59, e12599. <https://doi.org/10.1111/ejed.12599>
10. Weeks, J. O., Voshaar, J., Plate, B. J., & Zimmermann, J. (2024). Generative AI Usage and Exam Performance. *arXiv preprint arXiv:2404.19699*. <https://arxiv.org/abs/2404.19699>
11. Kanbul, S., Adamu, I., & Mohammed, Y. B. (2024). A Global Outlook on AI-Predicted Impacts of ChatGPT on Contemporary Education. *SAGE Open*, 14(3), 21582440241266370. <https://doi.org/10.1177/21582440241266370>
12. Abdallah, N., Katmah, R., Khalaf, K., & Jelinek, H. F. (2025). Systematic review of ChatGPT in higher education: Navigating impact on learning, wellbeing, and collaboration. *Social Sciences & Humanities Open*, 12, 101866. <https://doi.org/10.1016/j.ssaho.2025.101866>
13. Davar, N. F., Dewan, M. A. A., & Zhang, X. (2025). AI chatbots in education: challenges and opportunities. *Information* 16(3), 235. <https://doi.org/10.3390/info16030235>
14. Stöhr, C., Ou, A.W., & Malmström, H. (2024). Perceptions and usage of AI chatbots among students in higher education across genders, academic levels and fields of study. *Computers and Education: Artificial Intelligence*, 7, 100259. <https://doi.org/10.1016/j.caeai.2024.100259>
15. Saleem, F., Chikhaoui, E. & Malik M.I. (2024) Technostress in students and quality of online learning: role of instructor and university support. *Frontiers in Education*, 9, 1309642. <https://doi.org/10.3389/feduc.2024.1309642>
16. Toma, R.B., & Yáñez-Pérez, I. (2024). Effects of ChatGPT use on undergraduate students' creativity: a threat to creative thinking? *Discover Artificial Intelligence*, 4(1), 74. <https://doi.org/10.1007/s44163-024-00172-x>
17. Daud, N. M. (2025). From innovation to stress: analyzing hybrid technology adoption and its role in technostress among students. *International Journal of*

Simikić, V. & Aleksić, V. (2025). Negativan uticaj ChatGPT-a na obrazovanje. *STED Journal*, 7(2), 74-82.

- Educational Technology in Higher Education*, 22(1), 31.
<https://doi.org/10.1186/s41239-025-00529-x>
18. Wu, Q., Chen, L., Chen, M., & Huang, Y. (2025). Exploring the impact of artificial intelligence on business talent development in higher education: A systematic literature review and research agenda. *The International Journal of Management Education*, 24(1), 101287.
<https://doi.org/10.1016/j.ijme.2025.101287>
19. Matos, T., Santos, W., Zdravevski, E., Coelho, P. J., Pires, I. M., & Madeira, F. (2025). A systematic review of artificial intelligence applications in education: Emerging trends and challenges. *Decision Analytics Journal*, 15, 100571.
<https://doi.org/10.1016/j.dajour.2025.100571>
20. Pino Tarragó, J. C., Domínguez Gálvez, D.L., Regalado Jalca, J. J., & Villavicencio Cedeño, E. G. (2025). Artificial intelligence and soft skills in civil engineering education: A Latin American curriculum gap with global implications. *Research in Globalization*, 11, 100307.
<https://doi.org/10.1016/j.resglo.2025.100307>
21. Boulhrir, T., & Hamash, M. (2025). Unpacking artificial intelligence in elementary education: A comprehensive thematic analysis systematic review. *Computers and Education: Artificial Intelligence*, 9, 100442.
<https://doi.org/10.1016/j.caeai.2025.100442>

NEGATIVE IMPACT OF CHAT-GPT ON EDUCATION

Vesna Simikić, Veljko Aleksić

University of Kragujevac, Faculty of Technical Sciences, Svetog Save 65, Čačak, Serbia,
simikic.vesna.85@gmail.com, veljko.aleksic@ftn.kg.ac.rs

REVIEW SCIENTIFIC PAPER

ISSN 2637-2150

e-ISSN 2637-2614

UDC 004.738.5:004.89

DOI 10.63395/STEDJournal0702089S74

COBISS.RS-ID 143561217

Received: 14 October 2025.

Revised: 03 November 2025.

Accepted: 04 November 2025.

Published: 28 November 2025.

<https://stedjournal.com/>

Corresponding Author: author: Vesna Simikić, University of Kragujevac, Faculty of Technical Sciences, Svetog Save 65, Čačak, Serbia, simikic.vesna.85@gmail.com



Copyright © 2025 Vesna Simikić, & Veljko Aleksić; published by UNIVERSITY PIM. This work licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.

Citation: Simikić, V., & Aleksić, V. (2025). Negativan uticaj ChatGPT-a na obrazovanje. *STED Journal*, 7(2), 74-82.
<https://doi.org/10.63395/STEDJournal0702089S74>

ABSTRACT

The introduction of generative language models like ChatGPT into the education system brings numerous benefits, but also significant challenges that can negatively affect the quality of education. Analysis of the relevant scientific literature on the example of the use of artificial intelligence in education shows that excessive use can lead to a passive approach to learning, a decrease in motivation for independent thinking and the development of cognitive abilities, and an increase in the risk of academic dishonesty. A special challenge is the impact on competences, so students have a superficial understanding of programming and algorithmic thinking due to reliance on ready-made solutions. The paper highlights the need to develop clear pedagogical and ethical frameworks that would guide the responsible and critical use of artificial intelligence tools in education. In this sense, it is recommended to integrate AI literacy into curricula, redesign evaluations at higher levels of Bloom's Taxonomy, and empower teachers to guide students through active thought processes. A balanced and thoughtful approach can enable the optimal use of the advantages of ChatGPT, while preserving the quality and integrity of the educational process, especially in the field of information technology.

Keywords: ChatGPT, artificial intelligence, education, information technologies.

GUIDELINES FOR WRITING SCIENTIFIC PAPER FOR STED JOURNAL PUBLICATION

1. Use the Microsoft Word template to prepare your manuscript.
2. Make sure that issues about publication ethics, copyright, authorship, figure formats, data and references format have been appropriately considered.
3. Ensure that all authors have approved the content of the submitted manuscript.
4. Manuscripts submitted to STED Journal should neither been published before nor be under consideration for publication in another journal or conference.
5. Plagiarism in all its forms constitutes unethical publishing behavior and is unacceptable.

We are using professional tools from preventing plagiarism.



6. The recommended text processor is Microsoft Word (docx).
7. The paper can be written in English or in one of the official languages of Bosnia and Herzegovina (an extended Abstract and Keywords in English ar required).
8. Regular length of the paper is 6 to 20 pages.
9. Times New Roman 10 point's font should be used for normal text. The manuscript has to be prepared in two columns separated by 2".
10. Section titles (including references and acknowledgements) should be typed using 10 pt fonts with bold option (Caps Lock). Sections can be split in subsections, which should be typed in 10 pt options (bold - lower case) and next subsections 10 pt options (bold - italic - lower case).
11. Tables should be one column wide. If it is impossible to place the table in one column, two column width table is allowed. Each table must have a caption above the table - left alignment. For the table captions 9 pt font, should be used.
12. Figures should be one column wide. If it is impossible to place the figure in one column, two column width figure is allowed. Each figure must have a caption under the figure. For the figure captions 9 pt font, should be used.
13. Title - should be concise, omitting terms that are implicit and, where possible, be a statement of the main result or conclusion presented in the manuscript. Abbreviations should be avoided within the title.
14. Authors and affiliations - all names are listed together and separated by commas. Provide exact and correct author names as these will be indexed in official archives.
15. Corresponding author - clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication.
16. *Abstract* -insert an abstract of 100-250 words, giving a brief account of the most relevant aspects of the paper.
17. *Keywords* - it is recommended to use 4 to 6 keywords.
18. Introduction - state the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.
19. Material and methods - provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.
20. Results - should be clear and concise.

21. Discussion - this should explore the significance of the results of the work, not repeat them. A combined Results and discussion section is often appropriate. Avoid extensive citations and discussion of published literature.
22. Conclusion - be brief and state the most important conclusions from your paper. Do not use equations and figures here.
23. Acknowledgements - in this section you can acknowledge any support related to manuscript. Also provide here any information about funding by including specific grant numbers and titles.
24. References - STED Journal uses IEEE and APA styles. Use the IEEE style in the text and APA style in the reference section. Please ensure that every reference cited in the text is also present in the reference list (and vice versa).

TEMPLATE

First Author¹, Second Author², Third Author³

¹*First affiliation, Address, City, Country (e-mail)*

²*Second affiliation, Address, City, Country (e-mail)*

³*Third affiliation, Address, City, Country (e-mail)*

ABSTRACT

The instructions for writing a scientific paper for the STED Journal are given in this paper. The recommended text processor is Microsoft Word (docx). Insert an abstract of 150-200 words, giving a brief account of the most relevant aspects of the paper such as: literature review, problem under investigation, hypothesis/es, methods used, study results, and future implications of the study. Avoid using abbreviations, footnotes, references, or mathematical equations in abstract section. It is recommended to use up to 6 keywords.

Keywords: Camera ready paper, STED Journal, guideline.

INTRODUCTION

In order to ensure high quality of the papers, the authors are requested to follow instructions given in this sample paper. Regular length of the paper is 6 to 20 pages. The introduction section should provide review of the existing literature on the topic which will help contextualize your research within the broader scientific field and show the novelty of your work.

The introduction should also describe the question your research aims to answer and why that question is important to the field.

Make sure that paper is grammatically correct, the used terminology is formal, and that paper is properly formatted. Avoid using slangs and informal phrasal verbs.

Times New Roman 10 – point font should be used for normal text with “single” line spacing. The manuscript has to be prepared in two columns separated by 5 mm (0.2”). The text should be aligned to both the left and right (justified). The margins for A5 ISO (176×250 mm) paper are given in Table 1.

Table 1. Page layout description

Paper size	B5 ISO
Top margin	0.7”
Bottom margin	0.7”
Left margin	0.8”
Right margin	0.6”

A regular paper may consist of multiple sections. Title of each section (except acknowledgements sections) should be formatted with 10 - point font in bold (Caps Lock). Spacing between the title and the text should be “single”. The use of options “add space before/after paragraph” is not allowed.

Titles (subtitles) of sections can further be divided in subsections, which should use a 10 - point font in bold (lower case), following title case capitalization. Figures should be one column wide, centered, and in line with the text (select the table, right click, chose options “wrap text” and then “in line with text”). If it is impossible to place the figure or table in one column, two column width figures and tables are permissible. It is essential to ensure that all figures maintain a high quality with easily readable labels. Each figure must include a caption placed beneath it while table captions are placed above it. Tables/figures should be inserted in the text after they have been mentioned. When creating captions for figures and tables, use a 9-point font without punctuation at the end (e.g., Figure 1).



Figure 1. *Vriesea carinata* Wawra seedlings used in the experiment

All titles and the regular text should be in line (on the left side of the paper) such as:

INTRODUCTION

Writing Instructions

Subsection: Writing Introductions

Indent the first line of each paragraph of text with 0,3 – point from the left margin.

Each section should contain a brief introduction. When introducing abbreviations for the first time, provide full form of it, for example: Artificial Intelligence (AI).

METHODOLOGY SECTION

The aim of methodology section is to describe how your research was conducted as well as to enhance credibility of your research. In case your research is quantitative, methodology should present the way numerical data was collected and how mathematical analyses are conducted to observe, analyse, access, and test experiments and hypotheses. Qualitative research involves collection and analysis of non-numerical data (e.g.: text, video, or audio) with the aim of explaining concepts, opinions, perspectives, or personal experiences.

RESULTS

The results section describes the obtained findings gathered from your research. Provide appropriate figures and tables to effectively illustrate your results. Figures are used to present data trends or other visual information while tables are particularly useful when the exact values are important.

DISCUSSION

Discussion section should explain what the collected results mean and what is their importance and contribution to the field.

CONCLUSION

Be brief and state the most important conclusions from your paper as well as further implications for the field. Discuss benefits or shortcomings of your work and suggest future areas for research. Do not use equations, figures, or references here.

ACKNOWLEDGEMENTS (If any)

These and the Reference headings are in bold but have no numbers. Titles and text of sections references and acknowledgements should be formatted with 10 – point font, yet text in acknowledgements section should be in italic font. Include the names of the funding agencies or organizations, grant numbers - number of project, and any relevant details about the funding.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURE

References section is not enumerated. The use of hyperlinks should be avoided as much as possible. When including in-text references, they should be on the same level as the rest of the text e.g.: "References give proper credit to all work included [1]". For in-text references STED Journal prefers IEEE style (reference numbers in square brackets "[2], [3]") in combination with APA style (the use of authors' names with reference numbers, yet it is better to use only IEEE format as much as is possible). When citing the author's name, use the following format: 'as shown by Brown [4].' In cases where only the reference itself is included, use this format: 'References are of great importance in scientific papers [2]'. When including multiple sources, format them as follows: [5], [6], [7].

When introducing references in the reference list use 10 point font, following the form provided below [5]. Examples of the form:

1. Wong, B., & Kokko, H. (2005). Is science as global as we think? *Trends in Ecology & Evolution*, 20(9), 475-476.
2. Hennessy, J. L., & Patterson, D. A. (2012). *Computer architecture: A quantitative approach*. Elsevier.
3. Miller, T. (2019). *Enhancing readiness: An exploration of the New Zealand Qualified Firefighter Programme*. Master's thesis. Tuwhera: Auckland University of Technology.
4. Herculano-Houzel, S., Collins, C. E., Wong, P., Kaas, J. H., & Lent, R. (2008). The basic nonuniformity of the cerebral cortex. *Proceedings of the National Academy of Sciences of the United States of America*, 105(34), 12593-12598.
<https://doi.org/10.1073/pnas.0805417105>
5. Filipović, J. (2022). *Internet marketing*. Belegarde: University of Belgrade, Faculty of Economics.
6. FESTO. (2019). Fluidic Muscle DMSP/MAS. Retrieved 19 September 2022 from: https://www.festo.com/rep/en_corp/assets/pdf/info_501_en.pdf
7. Law on Criminal Procedure, Official Gazette of the Republic of Srpska, 72/2011, 101/2011, 121/2012, 32/2013, 45/2013, i 55/2014; Regulation (EU) No. 1052/2013 establishing the

European Border Surveillance System (Eurosur), OJ L 295 of 6/11/2013, 1; Directive 2013/32/EU on common procedures for granting and withdrawing international protection (recast), OJ L 180 of 29/6/2013, 60.

8. Supreme Court of Serbia, Rev. 1354/06, (6. 9. 2006). Paragraf Lex; Supreme Court of Serbia, Rev. 2331/96, 3. 7. 1996, Bulletin of the judicial practice of the Supreme Court of Serbia 4/96, 27; CJEU, case C-20/12, Giersch and Others, ECLI:EU:C:2013:411, para. 16; Opinion of AG Mengozzi to CJEU, case C-20/12, Giersch and Others, ECLI:EU:C:2013:411, para. 16.

COBISS Кооперативни online библиографски систем и сервиси COBISS
STED journal
Vol. 7, No. 1 (2025)
-bibliografija članaka-
Standard ISBD

1

ЛАКИЋ, Данијела

Uloga feminizma i jačanje zakonodavnog okvira protiv nasilja nad ženama u Bosni i Hercegovini / Danijela Lakić, Suzana Malešić. - Dostupno i na: <http://dx.doi.org/10.63395/STEDJournal0701074S100>. - Abstract

U: STED journal (Banja Luka). - ISSN 2637-2150. - Vol. 7, No. 1 (2025), pp. 100-109

343.85:343.62-055.2

COBISS.RS-ID [142632449](#)

2

СТАНАР, Сњежана З.

Relacije između osobina ličnosti, životnih stilova i akademske uspješnosti studenata / Snježana Stanar, Nevena Stanić. - Dostupno i na: <http://dx.doi.org/10.63395/STEDJournal0701076S1>. - Abstract

U: STED journal (Banja Luka). - ISSN 2637-2150. - Vol. 7, No. 1 (2025), pp. 1-17

159.923.3:378.4.014.55

COBISS.RS-ID [142630657](#)

3

ТЕШИЋ, Биљана

Attitudes and knowledge of the inhabitants of Serbia about artificial intelligence and its technologies / Biljana Tešić, Marko Pavlović. - Dostupno i na: <http://dx.doi.org/10.63395/STEDJ0701073E>. - Abstract

U: STED journal (Banja Luka). - ISSN 2637-2150. - Vol. 7, No. 1 (2025), pp. 58-76

007.52:330.341.1(497.11)

COBISS.RS-ID [142631425](#)

4

ЈОВОВИЋ, Јелена

Финансирање здравствених установа из средстава обавезног здравственог осигурања Републике Српске / Јелена Јововић, Младен Ивић, Жељко Грубљешић, Милош Тубић. - Dostupno i na: <http://dx.doi.org/10.63395/STEDJ10701076S110>. - Abstract

U: STED journal (Banja Luka). - ISSN 2637-2150. - Vol. 7, No. 1 (2025), pp. 110-118

336.6:614.2(497.6Република Српска)

COBISS.RS-ID [142632705](#)

5

ВУКИЧЕВИЋ, Мирослав

Analysis of marine fuel oil purifier efficiency, chemical elements and compounds found in them / Mirosлав Vukičević, Zdravko Ikica, Boris Hrnić, Vladan Vuković. - Dostupno i na: <http://dx.doi.org/10.63395/STEDJournal0701071E77>. - Abstract

U: STED journal (Banja Luka). - ISSN 2637-2150. - Vol. 7, No. 1 (2025), pp. 77-88

621.436:629.32

COBISS.RS-ID [142631681](#)

6

ПРЕМОВИЋ, Јелена

Enhancing insurance services in serbia with application of the servqual model / Jelena Premović, Marko M. Pavlović, Marijana Milunović. - Dostupno i na: <http://dx.doi.org/10.63395/STEDJournal0701069E37>. - Abstract

U: STED journal (Banja Luka). - ISSN 2637-2150. - Vol. 7, No. 1 (2025), pp. 37-57

368.03:330.322

COBISS.RS-ID [142631169](#)

7

ВУКИЧЕВИЋ, Мирослав

Modeling a purification system for efficient removal of abrasive impurities / Mirosлав Vukičević, Zdravko Ikica, Boris Hrnić, Vladan Vuković. - Dostupno i na: <http://dx.doi.org/10.63395/STEDJournal0701070E89>. - Abstract

U: STED journal (Banja Luka). - ISSN 2637-2150. - Vol. 7, No. 1 (2025), pp. 89-99

621.182.1:546.33'131

COBISS.RS-ID [142631937](#)

8

ЈОВЧИЋ, Ивана

Stavovi i stereotipi zdravstvenih radnika o uzrocima i elementima suicida / Ivana Jovčić. -
Dostupno i na: <http://dx.doi.org/10.63395/STEDJournal0701068S18>. - Abstract

U: STED journal (Banja Luka). - ISSN 2637-2150. - Vol. 7, No. 1 (2025), pp. 18-36

616.89-008.441/.442:614.2

COBISS.RS-ID [142630913](#)

Регистар наслова

- Финансирање здравствених установа из средстава обавезног здравственог осигурања Републике Српске [4](#)
- Analysis of marine fuel oil purifier efficiency, chemical elements and compounds found in them [5](#)
- Attitudes and knowledge of the inhabitants of Serbia about artificial intelligence and its technologies [3](#)
- Enhancing insurance services in serbia with application of the servqual model [6](#)
- Modeling a purification system for efficient removal of abrasive impurities [7](#)
- Relacije između osobina ličnosti, životnih stilova i akademske uspješnosti studenata [2](#)
- Stavovi i stereotipi zdravstvenih radnika o uzrocima i elementima suicida [8](#)
- Uloga feminizma i jačanje zakonodavnog okvira protiv nasilja nad ženama u Bosni i Hercegovini [1](#)

Регистар аутора

- Вукичевић, Мирослав, 1981- (аутор) [5](#), [7](#)
- Jovčić, Ivana - (аутор) 8
- Jovović, Jelena - (аутор) 4
- Лакић, Данијела, 1980- (аутор) [1](#)
- Premović, Jelena - (аутор) 6
- Станар, Сњежана З., 1978- (аутор) [2](#)

- Тешић, Биљана, 1963- (аутор) [3](#)
- Lakić, Danijela, 1980- (аутор) [1](#)
- Stanar, Snježana Z., 1978- (аутор) [2](#)
- Tešić, Biljana, 1963- (аутор) [3](#)
- Vukičević, Miroslav, 1981- (аутор) [5](#), [7](#)